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Texas ST-Elevation Myocardial Infarction (STEMI) and Heart Attack System of Care Report, 2017

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I. EXECUTIVE SUMMARY

The prevalence of heart attack in Texas has remained steady over the last few years, affecting about 4% of the adult resident population each year from 2011 to 2015 (Table 1). In order to advance heart attack reduction efforts, it is important to analyze the system of care, specifically for ST- Elevation Myocardial Infarction (STEMI), by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) has launched a Heart Attack and Stroke Data Collection Initiative.

Utilizing the time to treatment goals for primary percutaneous coronary intervention (PCI) and standards of care, percentages and medians were calculated using data collected from a group of hospitals that agreed to voluntarily participate in this data collection initiative. The data were collected by the Acute Coronary Treatment and Intervention Outcomes Network (ACTION) Registry-Get with the Guidelines (GWTG), a program of the American College of Cardiology in partnership with the American Heart Association and other societies, from the **fourth quarter of 2008 through the fourth quarter of 2016**. Currently 134 PCI-capable hospitals are participating in the ACTION Registry-GWTG in Texas. In 2016, when the highest number of hospitals were reporting for each measure, at most 49 out of these 134 PCI-capable hospitals were included (36.6%).

Substantial findings from the 2008-2016 Get With The Guidelines®- ACTION Registry data is as follows:

- **49** participating hospitals, distributed across **29** cities in Texas, provided data on individual episodes of care for heart attack. Most participating hospitals were located in urban or suburban communities and only **seven** hospitals were located in rural communities.
- **50,800** individual episodes of care for heart attack occurred among **48,575** patients at participating hospitals.
- Of the **50,800** episodes of care for heart attack that occurred:
    - **60.0%** involved patients who either transported themselves or were transported by family to the hospital where they were first evaluated;
    - **38.8%** arrived to the hospital by an ambulance;
    - **75.6%** involved patients receiving their first Electrocardiogram (ECG) upon arriving at the hospital;
    - **32.1%** involved care for STEMI heart attacks.
- The **median length of hospital stay** in each of the years between 2008 and 2016 was **three days**. The mean length of hospital stay in 2016 was **4.3 days**.
- Among patients who arrived by an **ambulance** between 2008 and 2016, only **51.3%** had pre-hospital ECG performed. In the year, 2016, among patients who had pre-hospital ECG performed, **79.1%** had pre-hospital ECG within 10 minutes (pgs.13,15)
- Between October 2008 and December 2016, the **median time** spent awaiting transfer from the STEMI referral hospital to the STEMI receiving hospital for PCI was

46 minutes among those who arrived by personal vehicle and **48 minutes** among those who arrived by ambulance (pg.21).

- Among directly admitted patients who arrived at a STEMI receiving hospital by ambulance, the **median** Emergency Department **(ED) dwell time** ranged from a low of **26 minutes** in 2016 to a high of **35 minutes** in 2009, 2010 and 2013 (pg.23).
- Among patients who arrived at a STEMI referral hospital by personal vehicle, the median time from arrival at STEMI referral hospital to primary PCI at a STEMI receiving hospital ranged from a low of **96.5 minutes** in 2014 to a high of **101 minutes** in 2011 and 2016. Among patients who arrived at a STEMI referral hospital by ambulance, the median time to primary PCI at a STEMI receiving hospital ranged from a low of **67 minutes** in 2011 to a high of **126** minutes in **2016** (pg.28).
- In 2016, the median time from first medical contact to balloon in directly admitted patients is **75** minutes and the median time in transfer patients is **137** minutes (pg.32).
- From 2011 to 2016, total ischemic time among STEMI transfer patients was calculated. Among patients who arrived by ambulance at the first hospital, **18.6%** had a total ischemic time less than 120 minutes, while among patients who arrived at the first hospital by personal vehicle, **11.1%** had a total ischemic time less than 120 minutes (pg.33).
- From 2011 to 2016, among patients who arrived by ambulance in 2016, **41.5%** had a total ischemic time less than 120 minutes, while among patients who arrived by personal vehicle in 2016, **23.8%** had a total ischemic time less than 120 minutes (pg.34).
- In 2016, among 267 STEMI transfer patients who arrived at the first hospital either by a personal vehicle or by an ambulance, the catheterization lab was activated prior to arrival for **43.1% of patients** (pg.37).
- In 2016, among 726 directly admitted STEMI patients who arrived at the hospital by ambulance, pre-catheterization lab activation occurred for **54.3%** of patients (pg.38).
- Between 2008 and 2016, the percentage of comorbidities among Acute Myocardial Infarction (AMI) patients was evaluated. Among 48,458 AMI patients, **77.7%** were hypertensive, **61.0%** had dyslipidemia, **42%** were obese, **39.8%** were diabetic, and **31.1%** were current or recent smokers (pg.40).
- Among 50,796 AMI patients between 2008 and 2016, **95.6%** were prescribed aspirin within first 24 hours, **2.2%** were not given and 2.1% have contraindications to aspirin use (pg.44).
- Among 50,796 AMI patients between 2008 and 2016, Beta-blockers were prescribed at discharge for **81%** of the patients, not prescribed for 2.6% of the patients, missing values in 11.1% and contraindicated in 5.4% of the patients (pg.46).
- Between 2008 and 2016, the unadjusted in-hospital mortality rates in STEMI patients ranged from as low as **5.2%** in 2008 to as high as **7%** in 2013 (pg.51).

II. INTRODUCTION

When blood flow through the heart's arteries is blocked, the heart is starved of oxygen and heart cells die. This is called a myocardial infarction or heart attack.[1] A STEMI heart attack is a serious type of heart attack that occurs when a heart's artery is completely blocked and a large part of the heart muscle is unable to receive blood.[2] This type of heart attack requires immediate treatment to restore blood flow to the heart.

III. BACKGROUND

In order to advance heart attack reduction efforts, it is important to analyze the system of care, specifically for STEMI, by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) has launched a Heart Attack and Stroke Data Collection Initiative. Through this initiative, hospitals are recruited to voluntarily share their data that focuses on pre-hospital and hospital data elements. This report includes de-identified, aggregate data for hospitals who have agreed to share ACTION Registry-GWTG data with DSHS. All data is intended to inform stakeholders about opportunities for collaboration and system enhancement. No hospital level data will be distributed, nor will any hospital name be identified in the report.

The objective of the data collection is to gain an understanding of the prevalence of heart attack in Texas, and evaluate pre-hospital components of the systems of care and treatment of heart attack patients. The findings will be used to assess policies and practices regarding delivery of care across the state and identify areas of opportunity for quality improvement.

IV. HEART ATTACK IN TEXAS

The prevalence of heart attack in Texas has remained steady over the last few years, affecting about 4% of the adult resident population each year from 2011 to 2015 (Table 1). In 2015, the prevalence of heart attack was twice as high among white adults (5.0%; 95% CI: 4.2-5.9) compared to Hispanic adults (2.9%; 95% CI: 2.2-3.7).

Table 1. Estimated number and unadjusted prevalence of adults, ages 18 years and older, that report ever having had a heart attack in Texas, by race/ethnicity and year

Year	No. of Adults	% of Adults (95% CI)	Race/Ethnicity			
			% White Only (95% CI)	% Black Only (95% CI)	% Hispanic (95% CI)	% Other only/ Multiracial (95% CI)
2011	740,234	4.1 (3.6-4.5)	4.6 (4.0-5.2)	4.6 (2.4-6.7)	2.9 (2.2-3.7)	4.2 (2.1-6.2)
2012	718,735	3.8 (3.3-4.2)	4.3 (3.7-4.9)	4.3 (2.7-5.9)	2.4 (1.7-3.1)	4.9 (2.3-7.5)
2013	763,932	3.9 (3.4-4.5)	4.4 (3.7-5.2)	6.2 (3.9-8.5)	2.6 (1.9-3.3)	--
2014	729,812	3.7 (3.2-4.1)	4.7 (4.1-5.4)	4.1 (2.2-6.0)	2.4 (1.8-3.0)	--
2015	862,314	4.3 (3.7-4.8)	5.0 (4.2-5.9)	5.3 (2.8-7.9)	2.9 (2.2-3.7)	--

Abbreviations: CI, confidence interval.
-- indicates data are not reportable due to small sample size.

However, using myocardial infarction (MI) hospitalization rates as an approximation of the incidence of disease, the overall rate of heart attacks has decreased since 2008 from 17.6 per 10,000 to 14.7 per 10,000 in 2014 (Table 2). Rates among whites and blacks have showed a similar decrease over time. The heart attack rate among Hispanics was significantly lower each year compared to whites or blacks, and the rate decreased significantly from 2008 (14.7 per 10,000) to 2014 (13.5 per 10,000). The rate of heart attacks among the other race category has fluctuated over the years but was significantly lower in 2014 than in 2008.

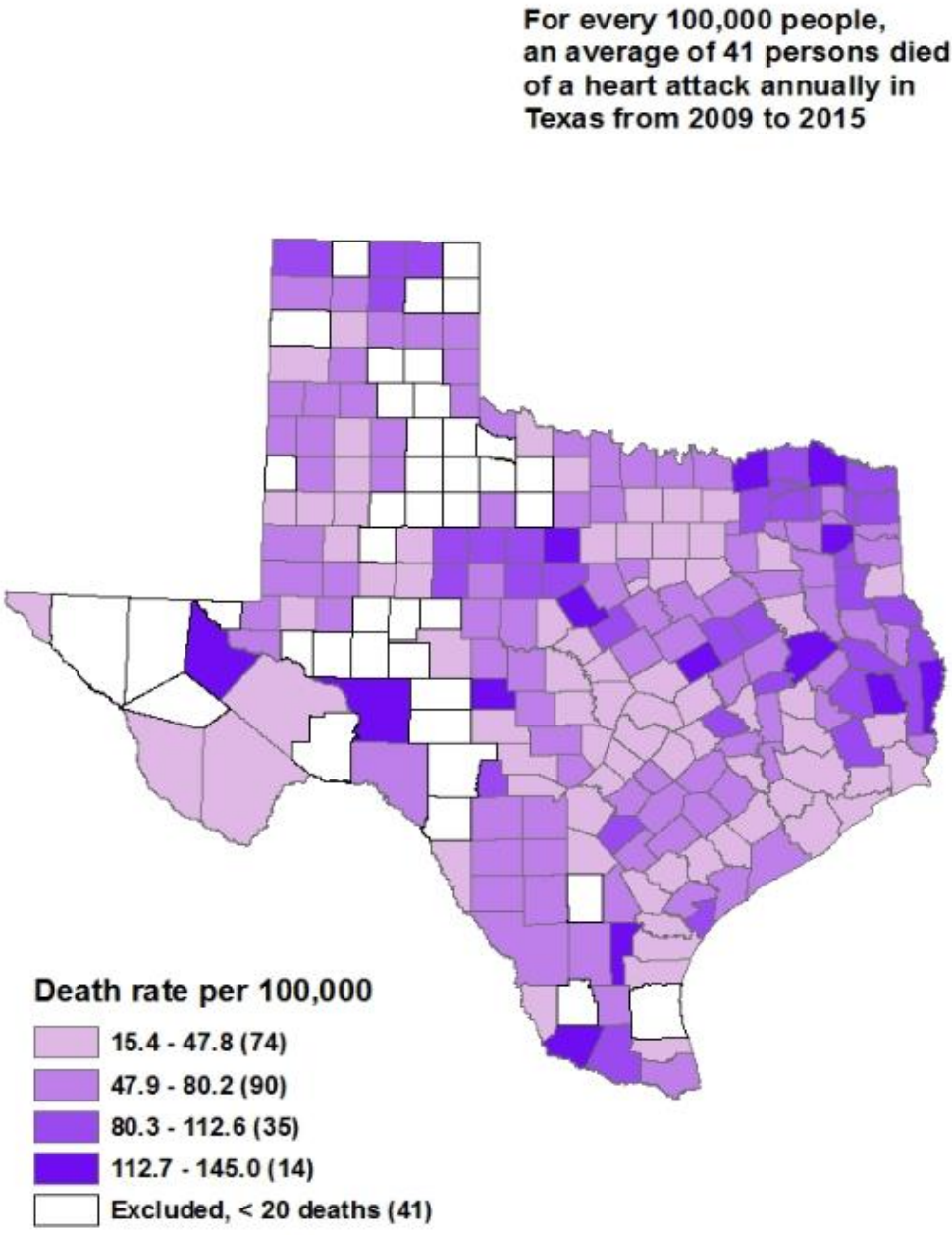
Table 2. Annual age-adjusted hospitalization rate (per 10,000) for heart attack among persons of all ages in Texas, by race/ethnicity and year

Year	No. of Hospitalizations	Age-Adjusted Hospitalization Rate (95% CI)		Race/Ethnicity			
				White (95% CI)	Black (95% CI)	Hispanic (95% CI)	Other (95% CI)
2008	36,983	17.6	(17.4-17.8)	18.0 (17.8-18.2)	17.8 (17.2-18.4)	14.7 (14.3-15.0)	35.0 (33.7-36.4)
2009	34,606	16.1	(15.9-16.2)	16.4 (16.2-16.6)	16.3 (15.8-16.9)	13.4 (13.1-13.8)	28.7 (27.6-29.9)
2010	35,675	16.0	(15.8-16.1)	16.0 (15.8-16.2)	16.2 (15.7-16.8)	14.2 (13.9-14.5)	30.7 (29.4-31.9)
2011	35,878	15.5	(15.4-15.7)	15.9 (15.7-16.1)	16.1 (15.6-16.7)	13.0 (12.7-13.3)	25.9 (24.9-27.0)
2012	37,911	15.9	(15.7-16.0)	15.1 (14.9-15.9)	15.4 (14.9-15.9)	13.9 (13.6-14.2)	40.1 (38.9-41.4)
2013	37,287	15.2	(15.0-15.3)	15.1 (14.9-15.3)	15.4 (14.9-15.9)	13.5 (13.2-13.8)	25.6 (24.7-26.6)
2014	38,304	14.7	(14.6-14.9)	14.6 (14.4-14.7)	15.0 (14.6-15.5)	13.5 (13.2-13.8)	25.6 (24.6-26.5)

Abbreviations: CI, confidence interval.

Looking at the geographic distribution of death rates, the highest rates emerge in counties located in east and northeast Texas (Figure 1).

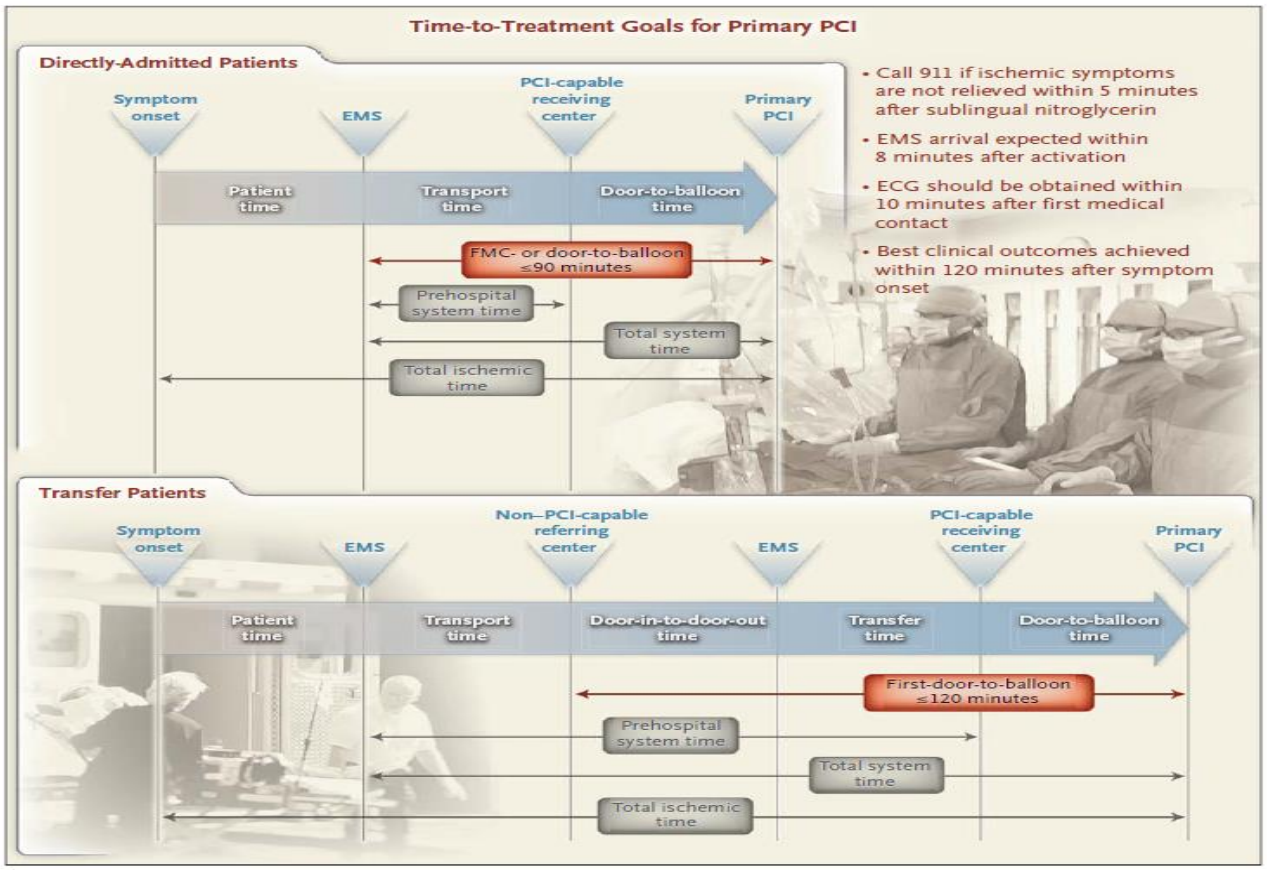
Figure 1. Age-adjusted average annual number of deaths due to heart attack per 100,000 people of all ages during 2009-2015, by county, in Texas



V. EVALUATING HOSPITAL CARE FOR HEART ATTACK IN TEXAS

PCI is the preferred reperfusion strategy for STEMI patients. There are approximately 154 PCI-capable hospitals in Texas that have a catheterization lab ready to perform PCI, 24 hours a day, 7 days a week.[3] These are often called "STEMI receiving hospitals." For hospitals that do not have this capability, often referred to as "STEMI referral hospitals," STEMI patients must be transferred to a PCI-capable hospital. **Figure 2** illustrates the time to treatment goals for primary PCI for patients who have been directly admitted to a STEMI receiving hospital and for those who have been transferred from a STEMI referral hospital.[6] The STEMI patients who are directly admitted to a STEMI receiving hospital are referred as directly admitted patients in the report and the STEMI patients who have been transferred from a STEMI referral hospital to a STEMI receiving hospital are referred as transfer patients.

Figure 2. Time to treatment goals for primary PCI [6]



Utilizing the time to treatment goals for primary PCI and standards of care, percentages and medians were calculated using data collected from a group of hospitals that agreed to participate in this data collection initiative. The data were collected by the ACTION Registry-GWTG from the **fourth quarter of 2008 through the fourth quarter of 2016**. Currently 134 PCI-capable hospitals are participating in the ACTION Registry-GWTG. In 2016, when the highest number of hospitals were reporting for each measure, at most

49 out of these 134 PCI-capable hospitals were included (36.6%). General findings from these data are as follows:

- **49** participating hospitals, distributed across **29** cities in Texas, provided data on individual episodes of care for heart attack.
- The **majority** of participating hospitals were located in **urban or suburban** communities, **7 (14.3%)** of which were located in the city of Dallas; only **7 (14.3%)** were located in **rural** communities.
- **50,800** individual episodes of care for heart attack occurred among **48,575** patients at participating hospitals.
- Of the **50,800** episodes of care for heart attack that occurred:
    - **60.0%** involved patients who either transported themselves or were transported by family to the hospital where they were first evaluated;
    - **75.6%** involved patients receiving their first ECG upon arriving at the hospital;
    - **32.1%** involved care for STEMI heart attacks.
    - **83.6%** had health insurance.
    - **95.7%** were alive at discharge.

Table 3 shows the number of participating hospitals and the reported heart attack cases from the year 2008 to 2016. The participating sites ranged from as few as 1 in 2008 to 49 in 2016. The reported heart attack cases were 97 in the year 2008 and 9,676 in the year 2016.

Table 3. Site participation and number of heart attack cases by year

Year	Participating sites	Reported Heart Attack Cases
2008	1	97
2009	5	798
2010	23	3,296
2011	29	5,475
2012	36	6,870
2013	38	7,404
2014	45	8,303
2015	48	8,881
2016	49	9,676

Table 4 displays the distribution of reported cases by subtype of heart attack. From 2008-2016, STEMI cases accounted for 32.1% of all reported cases and Non-STEMI accounted for 67.9%.

Table 4. Distribution of reported cases by heart attack subtype, 2008-2016

Heart Attack Type	Reported cases N=50,800	Percent of reported cases (%)
STEMI	16,289	32.1
Non-STEMI	34,511	67.9

Table 5 shows the demographic characteristics of patients reported between 2008 and 2016. Median age of the heart attack patients was 63. More than half of the patients (65.1%) in the database were men (n=33,049).

Table 5. Demographic characteristics of heart attack patients, 2008-2016

Characteristics	Number (%)
Age (years)	
Median (interquartile range)	63 (18)
Gender	
Men	33,049 (65.1)
Women	17,751 (34.9)
Race	
White	41,829 (82.3)
Black	6,591 (13.0)
Asian	973 (1.9)
American Indian	412 (0.8)
Native Hawaiian	54 (0.1)
Multiracial	88 (0.2)
No Race Reported	853 (1.7)
Ethnicity	
Hispanic	11,582 (22.8)
Non-Hispanic	39,023 (76.8)
Missing	195 (0.38)
Health Insurance Status	
Health insurance	42,466 (83.6)
Without health insurance	8,334 (16.4)

Table 6 shows the number of hospitals and heart attack cases in each community (urban/rural). Majority of heart attack and STEMI cases are in the urban areas.

Table 6. Number of hospitals and heart attack cases in each community, 2008 - 2016

Community	Number of Hospitals	Number of Heart Attack Cases	Percent of Heart Attack Cases	STEMI Cases	Percent of STEMI Cases
Urban	42	44,484	87.6%	14,254	87.5%
Rural	7	6,316	12.4%	2,035	12.5%
Total	49	50,800	100.0%	16,289	100.0%

Table 7 shows the number of heart attack cases by number of patient beds capacity in hospitals within geographic area urban vs. rural. Majority of heart attack cases (24,999), were admitted to hospitals with patient beds '100-349'. Hospitals with patient beds greater than 350 are found only in urban regions.

Table 7. Number of heart attack cases by patient beds within geographic area urban vs. rural

Patient Beds	Number of Heart Attack Cases	STEMI Cases	Community	Number of Hospitals
< 100	5,448	2,043	Both (Urban, Rural)	7
100 -349	24,999	7,796	Both (Urban, Rural)	27
350 -699	16,733	5,215	Urban	13
≥ 700	3,620	1,235	Urban	2
Total	50,800	16,289	---	49

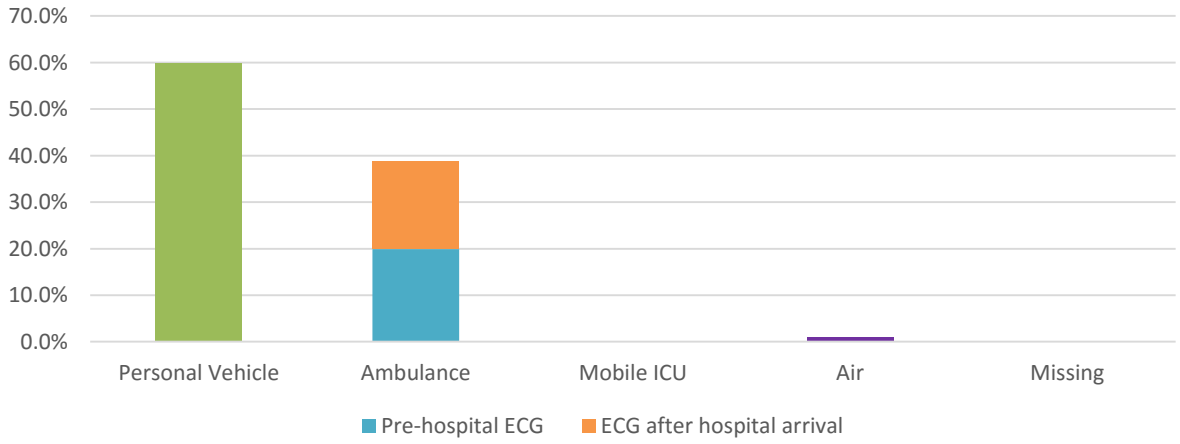
The **median length of hospital stay** in each of the years between 2008 and 2016 was **3 days**. The mean length of hospital stay in the year 2016 was **4.3 days**.

Arrival Method

According to the 2013 Texas Behavioral Risk Factor Surveillance System (BRFSS) survey, an estimated 86.9% of adults in Texas said they would call 911 if they thought someone was having a heart attack or stroke. The remaining 13.1% of adults said they would take other action such as taking the person to the hospital, telling them to call their doctor, call their spouse or family member, or do something else**.**

However, from the ACTION Registry data, 60.0% of the involved heart attack patients transported themselves or were transported by family to the hospital where they were first evaluated. Only 38.8% were transported by an ambulance to the hospital. Among those who arrived by an ambulance, only 51.3% had pre-hospital ECG performed.

Fig 3. Different Methods of hospital arrival among heart attack cases



The graphs and tables that follow display either **percentages** or **medians** for specific measures of effective care for heart attack. For measures with more than 100 cases reported for each mode of hospital arrival, the data are displayed by year using seven full years of data from the first quarter of 2009 through the fourth quarter of 2016 (January 2009-December 2016). For measures with less than 100 cases reported for each mode of hospital arrival, the data are cumulative using all available data from the fourth quarter of 2008 through the fourth quarter of 2016 (October 2008-December 2016). These estimates are stratified by **patient type**, that is, whether the patient was transferred in from another hospital or directly presented to a PCI-capable hospital. The measures include:

1. Pre-hospital ECG within 10 minutes of first medical contact
2. Time from first hospital arrival to first ECG
3. First ECG within 10 minutes of first hospital arrival
4. Dwell time in the emergency department (ED)

a. Dwell time in the emergency department of referral hospital
b. Dwell time in the emergency department of receiving hospital

5. First door to needle time for transfer patients
6. Door to needle time within 30 minutes for transfer patients
7. Door to balloon time for directly admitted patients

a. Median time from hospital arrival to primary PCI (in minutes)
b. Primary PCI within 90 minutes of hospital arrival

8. First door to balloon time for transfer patients

a. Median time from first hospital arrival to primary PCI (in minutes)
b. Primary PCI within 120 minutes of arrival to first hospital
c. Primary PCI within 90 minutes of arrival to first hospital

9. Median time from first medical contact to balloon time
10. Total Ischemic Time for STEMI transfer Patients
11. Total Ischemic Time for STEMI directly admitted Patients
12. Activation of catheterization lab prior to arrival among transfer patients
13. Activation of catheterization lab prior to arrival among directly admitted patients
14. Referral to rehabilitation
15. Percentage of AMI with comorbidities
16. Smoking cessation advice at discharge
17. Medications administered within first 24 hours
18. Medications prescribed at discharge

Additional information, including data source, inclusion criteria, and exclusion criteria can be found in Appendix I.

VI. PRE-HOSPITAL ECG WITHIN 10 MINUTES OF FIRST MEDICAL CONTACT

The ability to diagnose a STEMI early is the initial and one of the most important steps impacting heart attack survival. An Emergency Medical Services (EMS) unit equipped with 12-lead equipment (ECG capability) is able to identify a STEMI patient and communicate with the receiving hospital, leading to activation of the catheterization lab and a more efficient system of care. In an optimal system of care, a pre-hospital ECG will allow a heart attack patient to bypass the emergency department (ED) and advance directly to treatment in the catheterization lab.[5] The sooner EMS staff can perform an ECG and accurately interpret the findings, the timelier the communication of results to the receiving hospital, and the more time the receiving hospital has to prepare for the incoming patient.

Figure 4 and **Table 8** below displays the percentage of eligible episodes of care for heart attack in which patients received their first ECG within 10 minutes of first medical contact. The patients included in this measure arrived at the hospital by an ambulance equipped to perform pre-hospital ECGs.

Figure 4. Pre-Hospital ECG within 10 minutes of first medical contact among those arriving by ambulance and by year

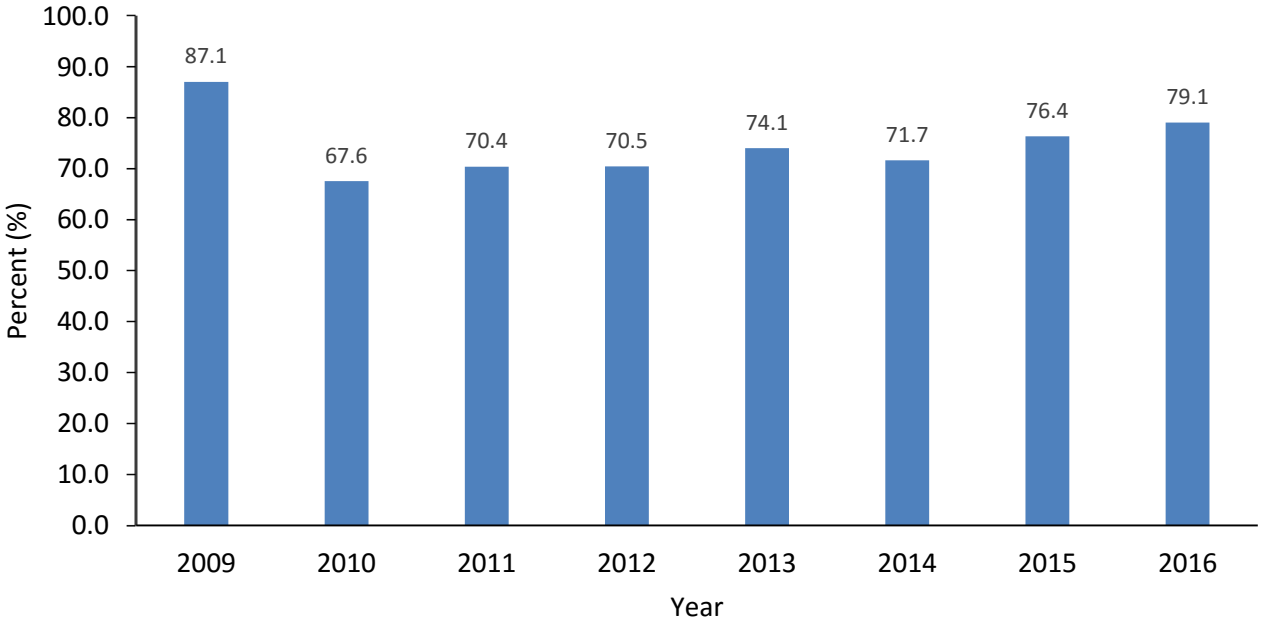


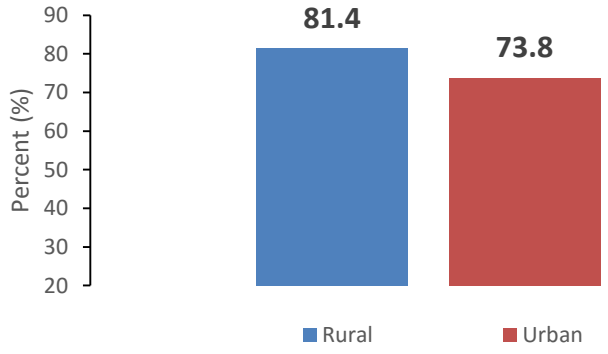
Table 8. Pre-Hospital ECG within 10 minutes of first medical contact among those arriving by ambulance and by year

Year	Cases with pre-hospital ECG (n)	Cases with pre-hospital ECG within 10 minutes of first medical contact (n)	% of cases with pre-hospital ECG within 10 minutes of first medical contact	Reporting hospitals (n)
2009	93	81	**87.1**	6
2010	376	254	**67.6**	18
2011	796	560	70.4	27
2012	1,184	835	70.5	35
2013	1,406	1,042	74.1	38
2014	1,747	1,252	71.7	44
2015	2,018	1,541	76.4	48
2016	2,487	1,967	79.1	48

In 2016, pre-hospital ECG within 10 minutes of first medical contact occurs in every 4 among 5 patients who received pre-hospital ECG. 79.7% of AMI patients received an ECG within 10 minutes in the rural areas and 79.0% of AMI patients received an ECG within 10 minutes in the urban areas.

There is an opportunity for improvement to increase the percentage of patients with pre-hospital ECG. In order to improve EMS performance in this measure, it is important to first consider ECG capability among the responding EMS units. Possessing the equipment to perform an ECG greatly affects the timeliness of care for heart attack patients. For those with 12-lead equipment, implementation of a standard EMS protocol for care of suspected heart attack patients should include performance of an ECG within 10 minutes of first medical contact.

Figure 5. Pre-Hospital ECG within 10 minutes of first medical contact among those arrived by ambulance and had pre-hospital ECG performed, by urban /rural area, 2008 - 2016



VII. TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG TRANSFER PATIENTS

Performing an ECG is the first step in heart attack care within the hospital, and not having one performed in a timely manner can have a detrimental effect on the patient's outcome. The national standard for hospital ECG performance time is within 10 minutes of arrival.[7] Rapid performance of ECG and interpretation can lead to reduced dwell time in the ED for a heart attack patient and timely activation of the catheterization lab.

Figure 6 and **Table 9** below display the median time (in minutes) elapsed from hospital arrival to receipt of first ECG among transfer patients with eligible episodes of care for heart attack, by mode of arrival to the first hospital and year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

Figure 6. Median time from first hospital arrival to first ECG among transfer patients by mode of arrival to first hospital and year

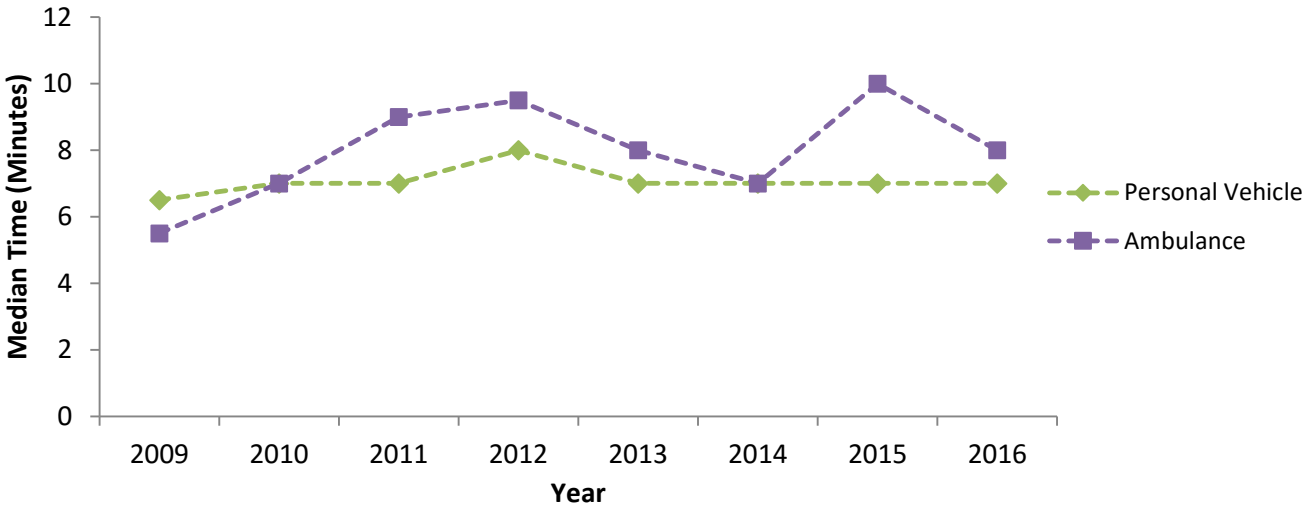


Table 9. Median time from first hospital arrival to first ECG among transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Year	Cases with ECG at STEMI referral hospital (n)	Median minutes	Cases with ECG at STEMI referral hospital (n)	Median minutes	Reporting hospitals (n)
2009	270	**6.5**	78	**5.5**	6
2010	570	7	191	7	17
2011	862	7	235	9	24
2012	1,034	**8**	242	9.5	32
2013	1,258	7	255	8	36
2014	1,260	7	217	7	43
2015	1,531	7	226	**10**	45
2016	1,534	7	206	8	46

VIII. TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG DIRECTLY ADMITTED PATIENTS

Figure 7 and **Table 10** below display the median time (in minutes) elapsed from hospital arrival to receipt of first ECG among directly admitted patients with eligible episodes of care for heart attack, by mode of arrival to the hospital and year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

Figure 7. Median time from first hospital arrival to first ECG among directly admitted patients by mode of arrival to hospital and year

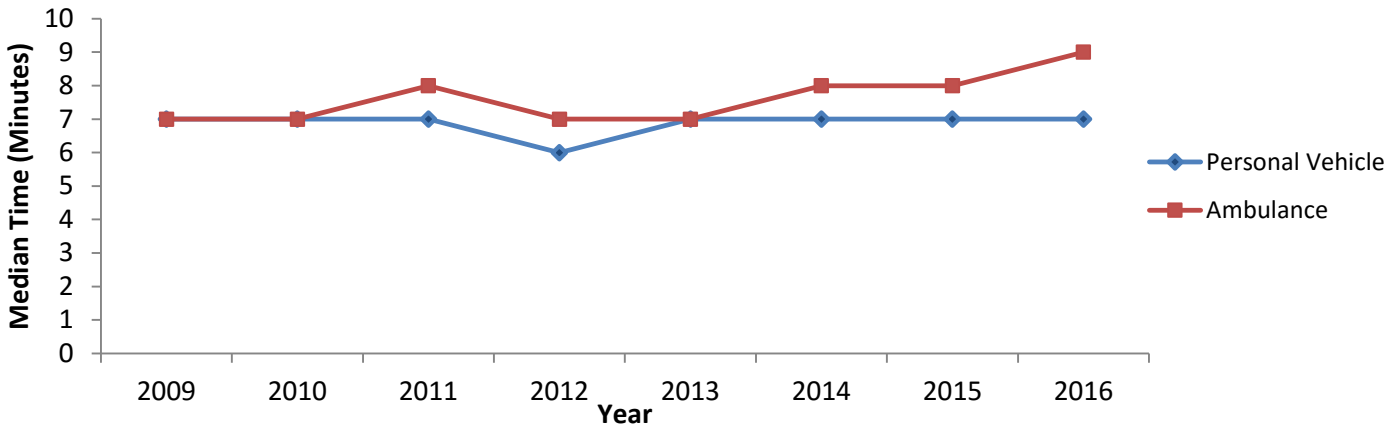


Table 10. Median time from hospital arrival to first ECG among directly admitted patients by mode of arrival to hospital and year

	Mode of arrival to hospital				
	Personal vehicle		Ambulance		
Year	Cases with ECG at STEMI receiving hospital (n)	Median minutes	Cases with ECG at STEMI receiving hospital (n)	Median minutes	Reporting hospitals (n)
2009	205	7	86	7	12
2010	1,213	7	568	7	23
2011	2,242	7	892	8	30
2012	2,898	**6**	985	7	36
2013	3,057	7	1,132	7	40
2014	3,657	7	1,095	8	45
2015	3,856	7	916	8	47
2016	4,264	7	711	**9**	49

The median time to first ECG for directly admitted patients who arrived by personal vehicle to the hospital ranged from a low of 6 minutes in 2012 to a high of 7 minutes in 2009 -2011 and 2013-2016. The median time for those who arrived by ambulance ranged from a low of 7 minutes in 2009 to2010 and 2012 to2013 to a high of 9 minutes in 2016.

IX. HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG TRANSFER PATIENTS

Figure 8 and **Table 11** below display the percentage of eligible episodes of care for heart attack in which transfer patients received an ECG within 10 minutes of arriving at the first hospital to which they presented, by mode of arrival to the first hospital and year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

Figure 8. Hospital ECG within 10 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

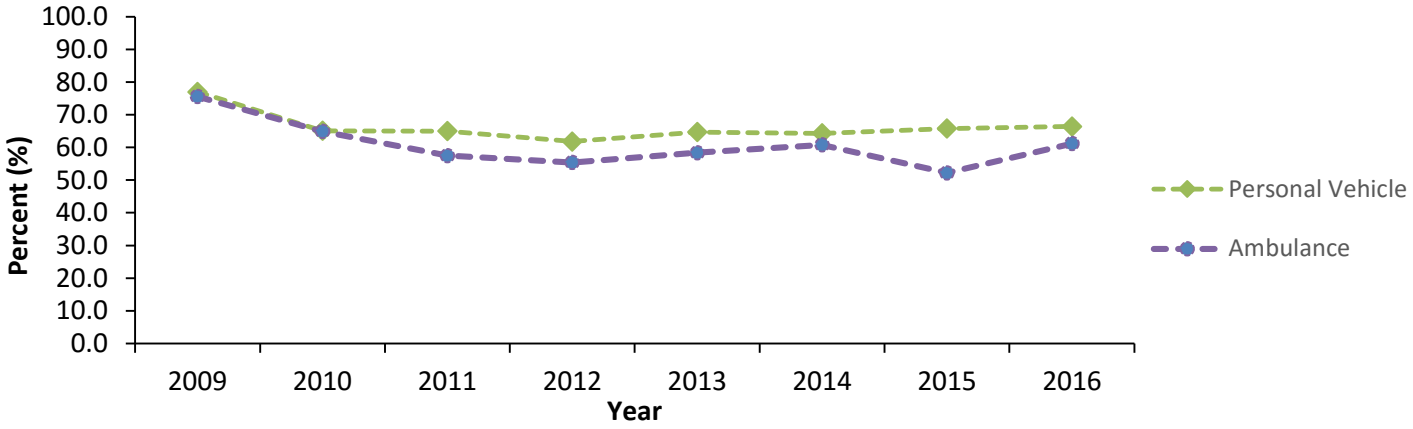


Table 11. Hospital ECG within 10 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
Year	Cases with ECG at STEMI referral hospital (n)	Cases with ECG within 10 minutes of arrival at STEMI referral hospital (n)	% of cases with ECG within 10 minutes of arrival at STEMI referral hospital	Cases with ECG at STEMI referral hospital (n)	Cases with ECG within 10 minutes of arrival at STEMI referral hospital (n)	% of cases with ECG within 10 minutes of arrival at STEMI referral hospital	Reporting hospitals (n)
2009	270	208	**77.0**	78	59	**75.6**	6
2010	570	371	65.1	191	124	64.9	17
2011	862	560	65.0	235	135	57.5	24
2012	1,034	639	**61.8**	242	134	55.4	32
2013	1,258	814	64.7	255	149	58.4	36
2014	1,260	810	64.3	217	132	60.8	43
2015	1,531	1,007	65.8	226	118	**52.2**	45
2016	1,534	1,018	66.4	206	126	61.2	46

There is opportunity for improvement in this vital component of care. Implementing an appropriate protocol within the hospital ED can lead to more efficient care and improved times on performance of ECG.

X. HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG DIRECTLY ADMITTED PATIENTS

Figure 9 and **Table 12** below display the percentage of eligible episodes of care for heart attack in which directly admitted patients received an ECG within 10 minutes of arriving at the hospital, by mode of arrival to the hospital and year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

Figure 9. Hospital ECG within 10 minutes of arrival among directly admitted patients by mode of arrival to hospital and year

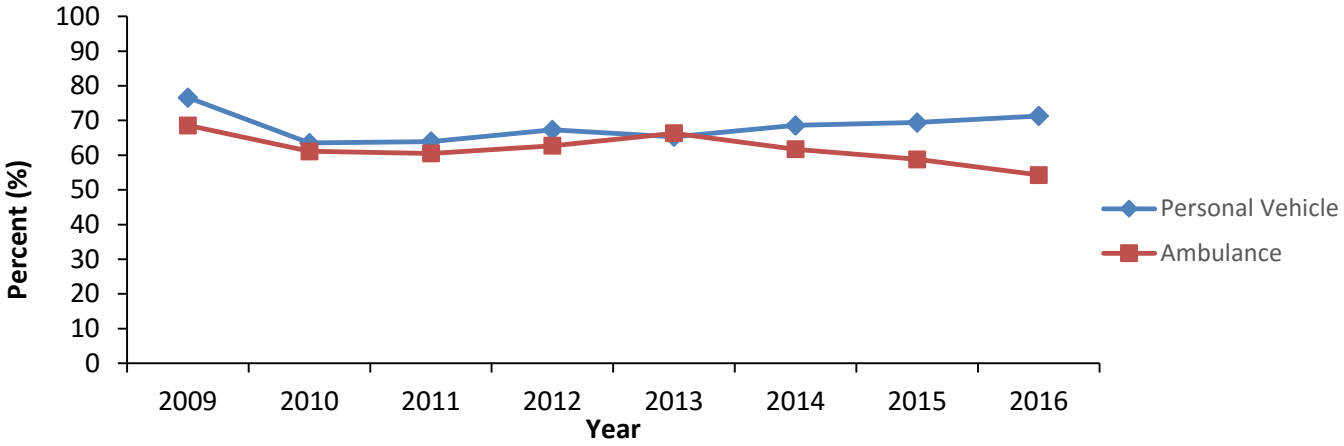


Table 12. Hospital ECG within 10 minutes of arrival among directly admitted patients by mode of arrival to hospital and year

	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
	Cases with ECG at STEMI receiving hospital (n)	Cases with ECG within 10 minutes of arrival at STEMI receiving hospital (n)	% of cases with ECG within 10 minutes of arrival at STEMI receiving hospital	Cases with ECG at STEMI receiving hospital (n)	Cases with ECG within 10 minutes of arrival at STEMI receiving hospital (n)	% of cases with ECG within 10 minutes of arrival at STEMI receiving hospital	Reporting hospitals (n)
2009	205	157	**76.6**	86	59	**68.6**	12
2010	1,213	770	**63.5**	568	347	61.1	23
2011	2,242	1,433	63.9	892	540	60.5	30
2012	2,898	1,951	67.3	985	618	62.7	36
2013	3,057	1,995	65.3	1,132	750	66.3	40
2014	3,657	2,507	68.6	1,095	676	61.7	45
2015	3,856	2,675	69.4	916	539	58.8	47
2016	4,264	3,041	71.3	711	386	**54.3**	49

Hospital ECG within 10 minutes of arrival is recommended both in transfer and directly admitted patients irrespective of their mode of arrival. Even if the report shows that a higher number of patients arriving by a personal vehicle had a hospital ECG within 10 minutes of arrival, it is always recommended for heart attack patients to arrive by an ambulance. This is because recognition of STEMI when ECG is performed in an ambulance, can lead to timely activation of cardiac catheterization lab, which can decrease the total ischemic time and improve patient clinical outcomes.

XI. DWELL TIME IN THE EMERGENCY DEPARTMENT OF REFERRAL HOSPITAL

The standard of care for time from arrival at first hospital to PCI, including transfer time, is 120 minutes.[6] This transfer process adds another component that must be evaluated as part of the STEMI system of care. The time spent in the referral facility is critical in this transfer process. It is an element that can be improved through streamlined processes and protocols, whereas transport time is more difficult to address due to other factors such as distance to closest receiving hospital.

Figure 10 and **Table 13** below display the median time (in minutes) spent awaiting transfer from the STEMI referral hospital to the STEMI receiving hospital for PCI among eligible episodes of care for STEMI heart attack, by mode of arrival to the STEMI referral hospital.

Figure 10. Median time spent in the emergency department (ED) of the STEMI referral hospital among transfer patients by mode of arrival to first hospital

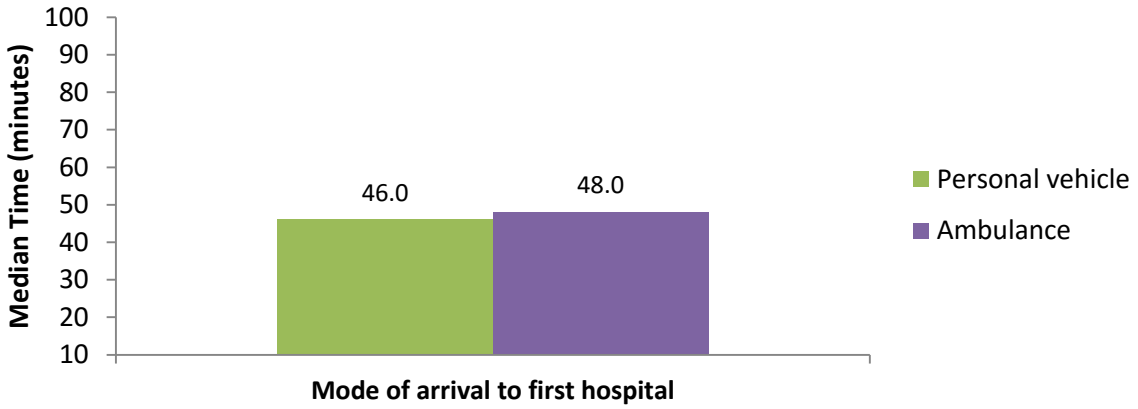


Table 13. Median time spent in the ED of the STEMI referral hospital among transfer patients

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Patient Type	STEMI cases (n)	Median minutes	STEMI cases (n)	Median minutes	Reporting hospitals (n)
Transfer from other hospital	97	**46.0**	30	**48.0**	10

The median time spent awaiting transfer from the STEMI referral hospital to the STEMI receiving hospital for PCI was 46 minutes among those who arrived by personal vehicle and

48 minutes among those who arrived by ambulance. For referral hospitals, there should be appropriate protocols in place for identifying a STEMI patient and transferring and transporting them to a receiving hospital. Implementing such a protocol requires rapid performance and interpretation of ECG and communication to the receiving hospital for activation of its catheterization lab.

XII. DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG TRANSFER PATIENTS

Figure 11 and **Table 14** below display the median time (in minutes) spent waiting in the ED of the STEMI receiving hospital among transfer patients with eligible episodes of care for STEMI heart attack, by mode of arrival to first hospital and year.

Figure 11. Median time spent in the ED of the STEMI receiving hospital among transfer patients by mode of arrival to first hospital and year

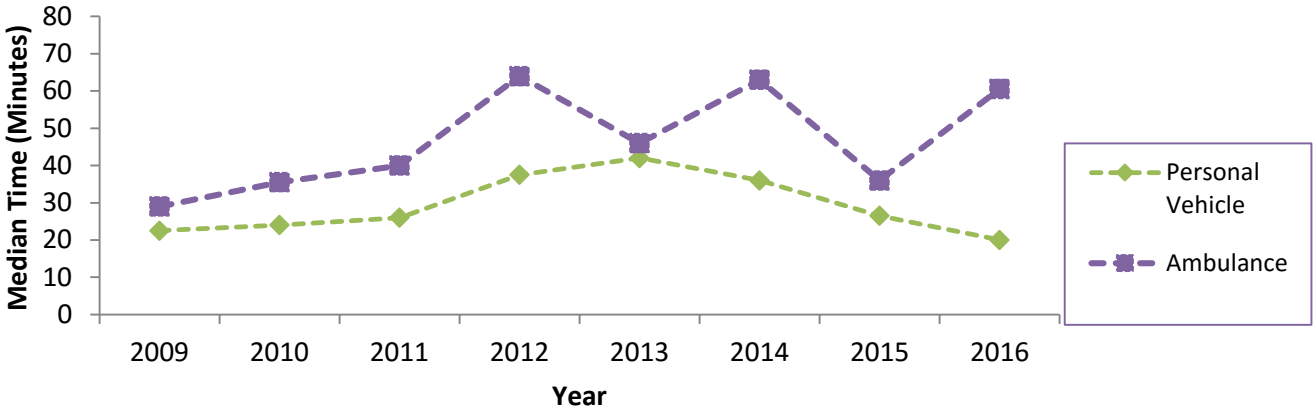


Table 14. Median time spent in the ED of the STEMI receiving hospital among transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Year	STEMI cases (n)	Median minutes	STEMI cases (n)	Median minutes	Reporting hospitals (n)
2009	20	22.5	5	**29**	2
2010	43	24	34	35.5	10
2011	101	26	28	40	15
2012	112	37.5	41	**64**	18
2013	123	**42**	21	46	19
2014	123	36	31	63	24
2015	128	26.5	29	36	29
2016	162	**20**	30	60.5	28

There is opportunity for improving communication and establishing protocols between STEMI receiving and referral hospitals to reduce dwell time in the ED of the STEMI receiving hospital.

XIII. DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG DIRECTLY ADMITTED PATIENTS

Figure 12 and **Table 15** below display the median time (in minutes) spent waiting in the ED of STEMI receiving hospital among directly admitted patients with eligible episodes of care for STEMI heart attack, by mode of arrival to hospital and year.

Figure 12. Median time spent in the ED of the STEMI receiving hospital among directly admitted patients by mode of arrival to hospital and year

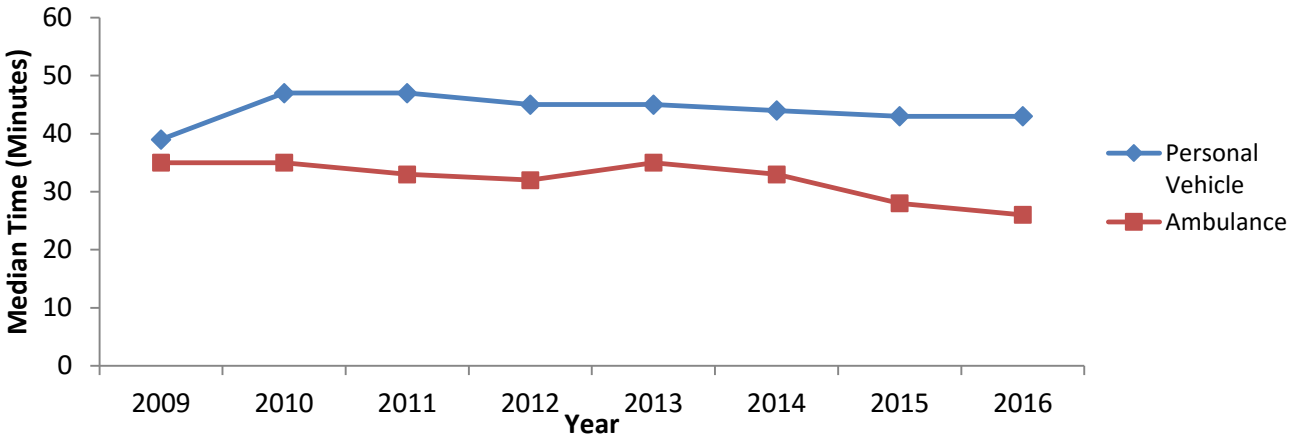


Table 15. Median time spent in the ED of the STEMI receiving hospital among directly admitted patients by mode of arrival to hospital and year

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Year	STEMI Cases (n)	Median minutes	STEMI Cases (n)	Median minutes	Reporting hospitals (n)
2009	61	**39**	67	**35**	9
2010	255	**47**	241	**35**	21
2011	454	**47**	486	33	27
2012	578	45	581	32	34
2013	614	45	754	**35**	35
2014	746	44	785	33	43
2015	792	43	877	28	47
2016	812	43	948	**26**	49

XIV. FIRST DOOR TO NEEDLE TIME

Fibrinolysis, or use of a clot-dissolving drug to restore blood flow, can be used by hospitals that are not PCI-capable and cannot transfer a patient to receive PCI within the

recommended time or for patients ineligible for PCI. Fibrinolytic therapy should be administered within 30 minutes of hospital arrival.[7]

Figure 13 and **Table 16** below display the median time (in minutes) elapsed from arrival at first hospital to receipt of fibrinolytic therapy as primary reperfusion treatment among eligible episodes of care for STEMI heart attack, by mode of arrival to first hospital. The patients included in this measure were later transferred to another hospital. The measure reflects median time from arrival at the first hospital to receipt of fibrinolytic therapy as primary reperfusion treatment at the first hospital. It is important to note the number of eligible patients for this measure was less than 100.

Figure 13. Median time from first hospital arrival to primary fibrinolysis among transfer patients by mode of arrival to first hospital

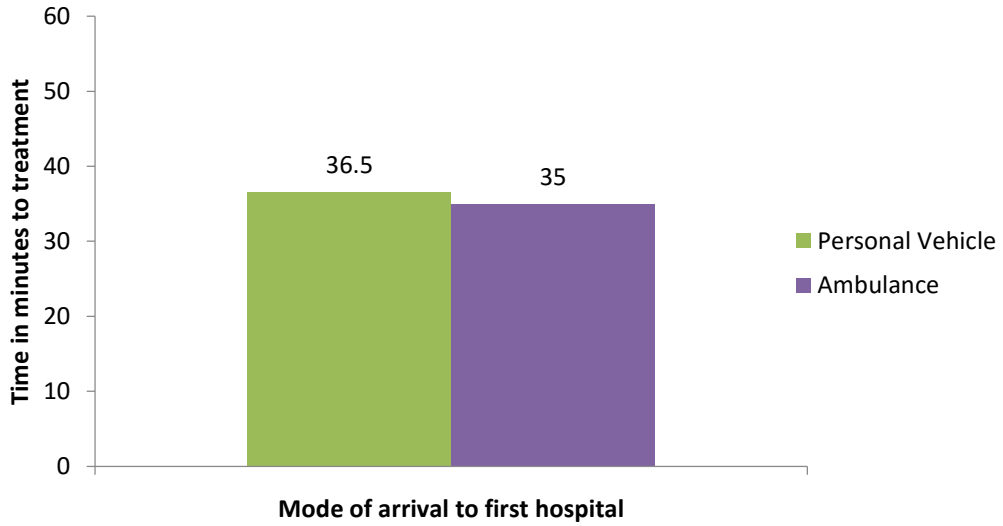


Table 16. Median time from first hospital arrival to primary fibrinolysis among transfer patients by mode of arrival to first hospital

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Patient Type	Cases receiving fibrinolysis at STEMI referral hospital (n)	Median minutes	Cases receiving fibrinolysis at STEMI referral hospital (n)	Median minutes	Reporting hospitals (n)
Transfer from other hospital	86	**36.5**	29	**35.0**	17

Among patients who arrived at the first hospital by personal vehicle, the median time to fibrinolytic therapy was 36.5 minutes from first hospital arrival, compared to a median time of 35 minutes to fibrinolytic therapy for those arriving by ambulance.

XV. DOOR TO NEEDLE TIME WITHIN 30 MINUTES AMONG TRANSFER PATIENTS

Figure 14 and **Table 17** below display the percentage of eligible patients receiving primary fibrinolysis within 30 minutes, by mode of arrival to first hospital. The patients included in this measure were later transferred to another hospital. The measure reflects the percent of patients who received fibrinolytic therapy as the primary reperfusion strategy within 30 minutes from arrival at the first hospital. It is important to note the number of eligible patients for this measure was less than 100.

Figure 14. Fibrinolysis within 30 minutes of hospital arrival among transfer patients by mode of arrival to first hospital

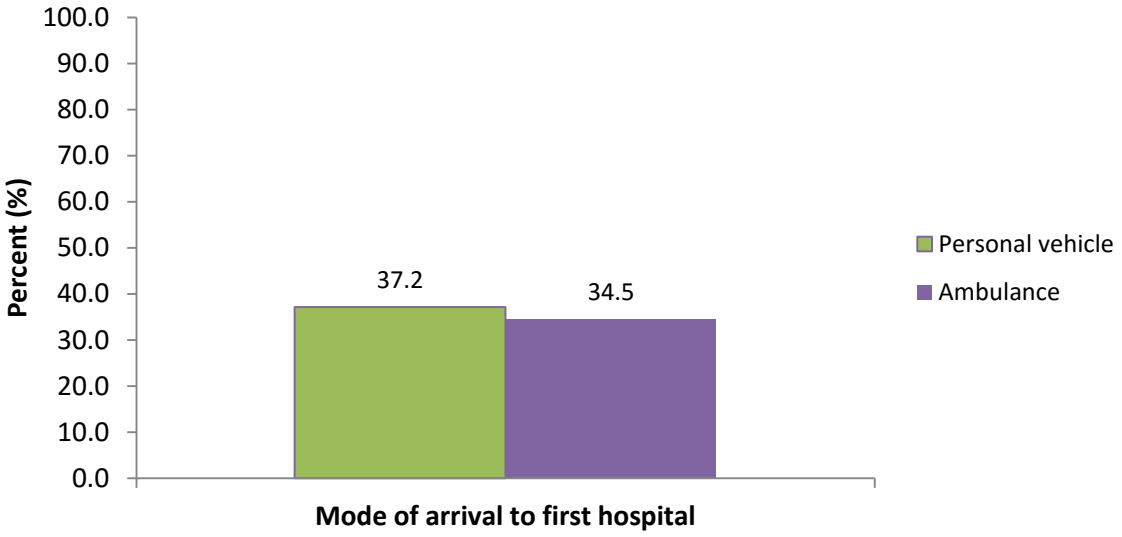


Table 17. Fibrinolysis within 30 minutes of hospital arrival among transfer patients by mode of arrival to first hospital

Patient Type	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
	Cases receiving fibrinolysis at STEMI referral hospital (n)	Cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital (n)	% of cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital	Cases receiving fibrinolysis at STEMI referral hospital (n)	Cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital (n)	% of cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital	Reporting hospitals (n)
Transfer from other hospital	86	32	**37.2**	29	10	**34.5**	17

The recommended door to needle time in referral hospitals is 30 minutes. In Texas, between the years 2008 and 2016, only 37.2% of the patients who arrived at a referral hospital by

a personal vehicle and 34.5% who arrived by an ambulance met this criteria. The rapid performance of ECG and reduction of dwell times in the emergency departments of referral hospitals can improve this measure.

XVI. DOOR TO BALLOON TIME FOR DIRECTLY ADMITTED PATIENTS

PCI is the preferred reperfusion strategy for STEMI patients. The standard of care for time from hospital arrival to PCI or device activation, commonly referred to as door to balloon time, is 90 minutes.[7] **Figure 15** and **Table 18** below display the median time (in minutes) elapsed from arrival at a STEMI receiving hospital to primary PCI among eligible episodes of care for STEMI heart attack, by mode of arrival and year. This measure is significant because it encompasses all the previous steps that are required for care of STEMI patients from arrival at the hospital, time in ED, arrival in the catheterization lab, and device activation.

Figure 15. Median time from hospital arrival to primary PCI among directly admitted patients by mode of arrival and year

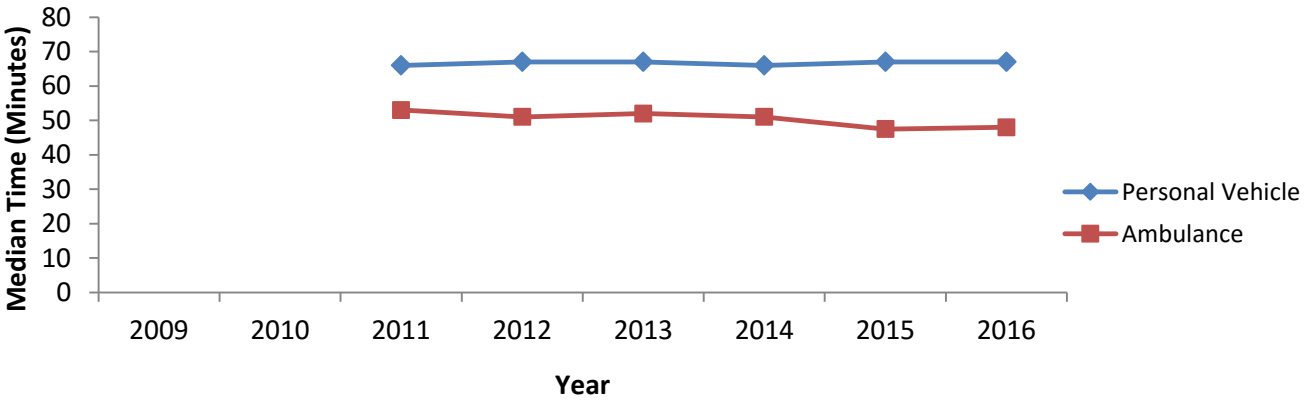


Table 18. Median time from hospital arrival to primary PCI among directly admitted patients by mode of arrival and year

	Mode of arrival to hospital				
	Personal vehicle		Ambulance		
Year	Cases receiving primary PCI at hospital (n)	Median minutes	Cases receiving primary PCI at hospital (n)	Median minutes	Reporting hospitals (n)
2009	--	--	--	--	--
2010	--	--	--	--	--
2011	293	**66**	316	**53**	29
2012	432	**67**	460	51	34
2013	471	**67**	601	52	36
2014	552	**66**	613	51	43
2015	557	**67**	642	**47.5**	46
2016	602	**67**	726	48	48

-- No data available

Patients who arrived by ambulance had a lower median time to PCI than those who arrived by personal vehicle. In order to further improve the median time to PCI, hospitals can evaluate the protocol for activation of the catheterization lab and aim to have catheterization lab staff arrive within 30 minutes of the activation call.

XVII. DOOR TO BALLOON TIME WITHIN 90 MINUTES FOR DIRECTLY ADMITTED PATIENTS

Figure 16 and **Table 19** below displays the percentage of eligible episodes of care for STEMI heart attack and patients who received primary PCI within 90 minutes of direct presentation to a STEMI receiving hospital, by mode of arrival and year.

Figure 16. Primary PCI within 90 minutes of hospital arrival among directly admitted patients by mode of arrival and year

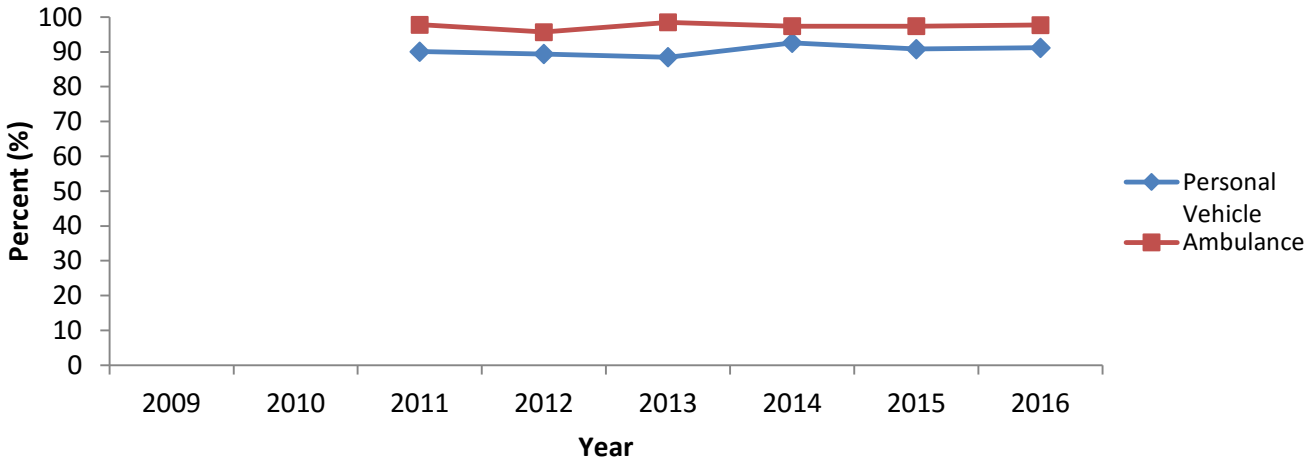


Table 19. Primary PCI within 90 minutes of hospital arrival among directly admitted patients by mode of arrival and year

	Mode of arrival to hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at hospital (n)	Cases receiving primary PCI within 90 minutes of hospital arrival (n)	% of cases receiving primary PCI within 90 minutes of hospital arrival	Cases receiving primary PCI at hospital (n)	Cases receiving primary PCI within 90 minutes of hospital arrival (n)	% of cases receiving primary PCI within 90 minutes of hospital arrival	Reporting hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	293	264	90.1	316	309	97.8	29
2012	432	386	89.4	460	440	**95.7**	34
2013	471	417	**88.5**	601	592	**98.5**	36
2014	552	511	**92.6**	613	597	97.4	43
2015	557	506	90.8	642	625	97.4	46
2016	602	549	91.2	726	709	97.7	48

-- No data available

A higher percent of patients who arrived by ambulance received primary PCI within 90 minutes of hospital arrival than those who arrived by personal vehicle.

XVIII. FIRST DOOR TO BALLOON TIME FOR TRANSFER PATIENTS

STEMI heart attack patients who arrive at a STEMI referral hospital and are eligible for and in need of PCI must be transferred to a STEMI receiving hospital to receive appropriate care and treatment. The standard of care for time from arrival at first hospital to PCI, including transfer time, is 120 minutes.[6] **Figure 17** and **Table 20** below display the median time (in minutes) elapsed from arrival at a STEMI referral hospital to receipt of primary PCI at a STEMI receiving hospital among eligible episodes of care for STEMI heart attack, by mode of arrival to the STEMI referral hospital.

Figure 17. Median time from first hospital arrival to primary PCI for transfer patients by mode of arrival to first hospital and year

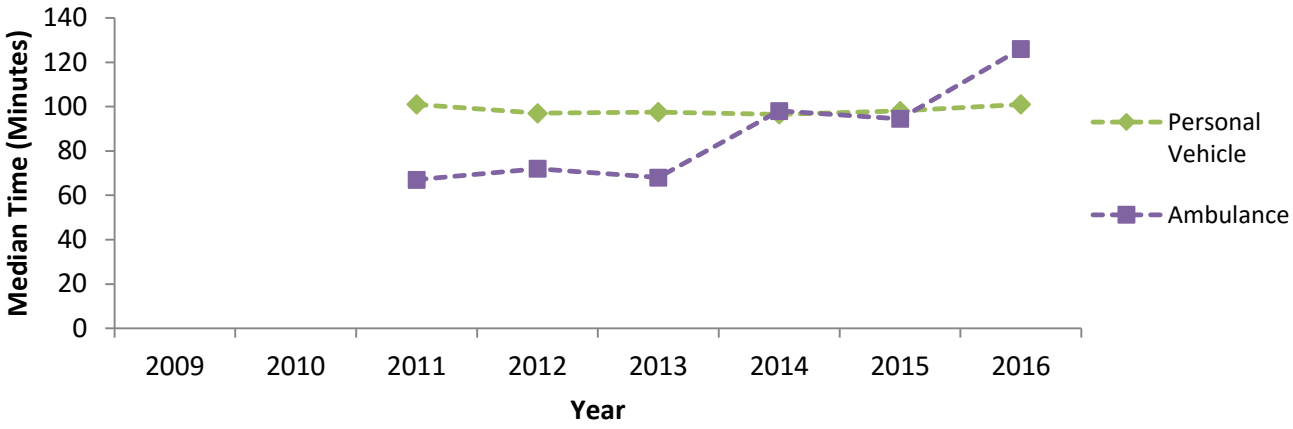


Table 20. Median time from first hospital arrival to primary PCI for transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital				
	Personal vehicle		Ambulance		
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Median minutes	Cases receiving primary PCI at STEMI receiving hospital (n)	Median minutes	Reporting hospitals (n)
2009	--	--	--	--	--
2010	--	--	--	--	--
2011	158	**101**	77	**67**	19
2012	195	97	91	72	23
2013	212	97.5	75	68	26
2014	220	**96.5**	34	98	31
2015	261	98	44	94.5	31
2016	243	**101**	22	**126**	33

-- No data available

In 2016, patients who arrived at a STEMI referral hospital by ambulance had a higher median time to primary PCI than those who arrived at the referral hospital by personal vehicle. This is due to increase in the dwell times in the emergency department of receiving hospitals for transfer patients who arrived at first hospital by an ambulance.

XIX. FIRST DOOR TO BALLOON TIME WITHIN 120 MINUTES FOR TRANSFER PATIENTS

Figure 18 and **Table 21** below display the percentage of eligible episodes of care for STEMI heart attack patients who received primary PCI at a STEMI receiving hospital within 120 minutes of arriving at a STEMI referral hospital, by mode of arrival to the STEMI referral hospital and year.

Figure 18. Primary PCI within 120 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

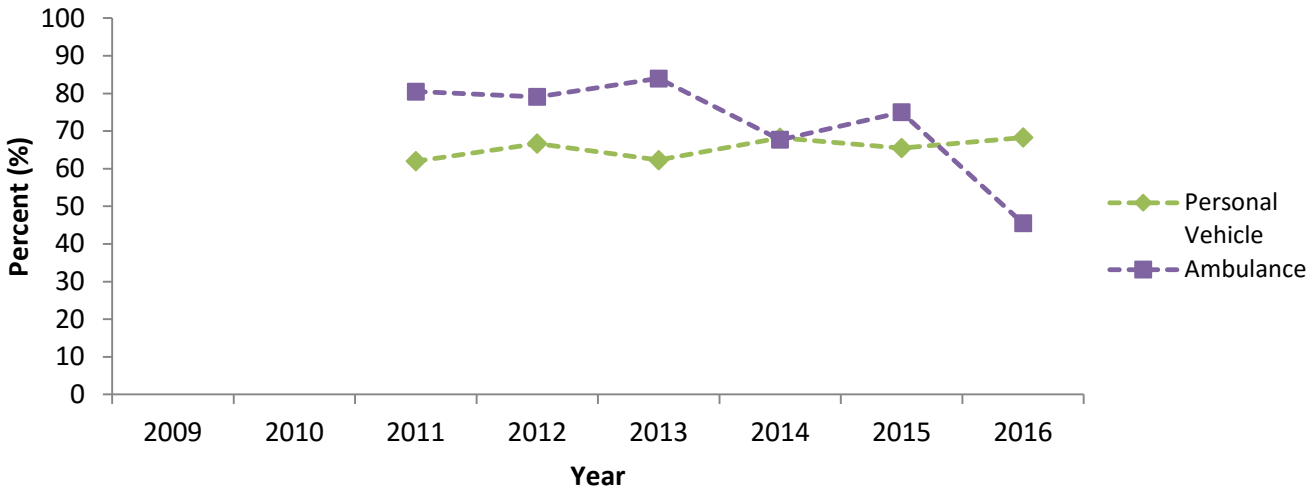


Table 21. Primary PCI within 120 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 120 minutes of first hospital arrival (n)	% of cases receiving primary PCI within 120 minutes of first hospital arrival	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 120 minutes of first hospital arrival (n)	% of cases receiving primary PCI within 120 minutes of first hospital arrival	Reporting hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	158	98	**62.0**	77	62	80.5	19
2012	195	130	66.7	91	72	79.1	23
2013	212	132	62.3	75	63	**84.0**	26
2014	220	150	68.2	34	23	67.7	31
2015	261	171	65.5	44	33	75.0	31
2016	243	166	**68.3**	22	10	**45.5**	33

-- No data available

In 2016, a lower percentage of patients who arrived at a STEMI referral hospital by ambulance received primary PCI within 120 minutes of arrival than those who arrived at the referral hospital by personal vehicle.

XX. FIRST DOOR TO BALLOON TIME WITHIN 90 MINUTES FOR TRANSFER PATIENTS

According to American Heart Association's (AHA)STEMI systems of care recommendations, the door to balloon time for transfer patients, including transport time, should be within 90 minutes.[5] **Figure 19** and **Table 22** below display the percentage of eligible episodes of care for STEMI patients who received primary PCI at a STEMI receiving hospital within 90 minutes of arriving at a STEMI referral hospital, by mode of arrival to the STEMI referral hospital and year.

Figure 19. Primary PCI within 90 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

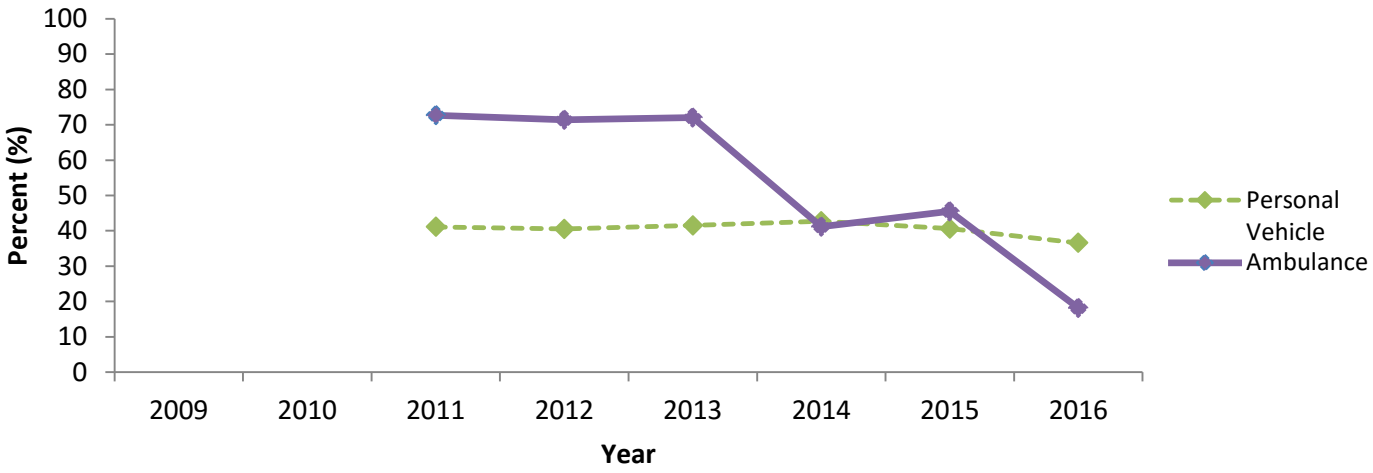


Table 22. Primary PCI within 90 minutes of first hospital arrival among transfer patients by mode of arrival to first hospital and year

	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	% of cases receiving primary PCI within 90 minutes of first hospital arrival	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	% of cases receiving primary PCI within 90 minutes of first hospital arrival	Reporting hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	158	65	41.1	77	56	**72.7**	19
2012	195	79	40.5	91	65	71.4	23
2013	212	88	41.5	75	54	72.0	26
2014	220	94	**42.7**	34	14	41.2	31
2015	261	106	40.6	44	20	45.5	31
2016	243	89	**36.6**	22	4	**18.2**	33

-- No data available

In 2016, a lower percentage of patients who arrived at a STEMI referral hospital by ambulance received primary PCI within 90 minutes of arrival than those who arrived at the referral hospital by personal vehicle.

XXI. FIRST MEDICAL CONTACT TO BALLOON TIME

According to 2013 American College of Cardiology Foundation and AHA STEMI guidelines, the focus and emphasis has shifted to targeting first medical contact to balloon time rather than door to balloon time.[14] **Figure 19** and **Table 23** below display the median time from first medical contact to balloon time by year for STEMI heart attack patients who arrived by an ambulance to the first hospital. Both the transfers and directly admitted patients were included.

Fig 20. Median time from first medical contact to balloon time by year among patients who arrived at the first or only hospital by ambulance, by patient type

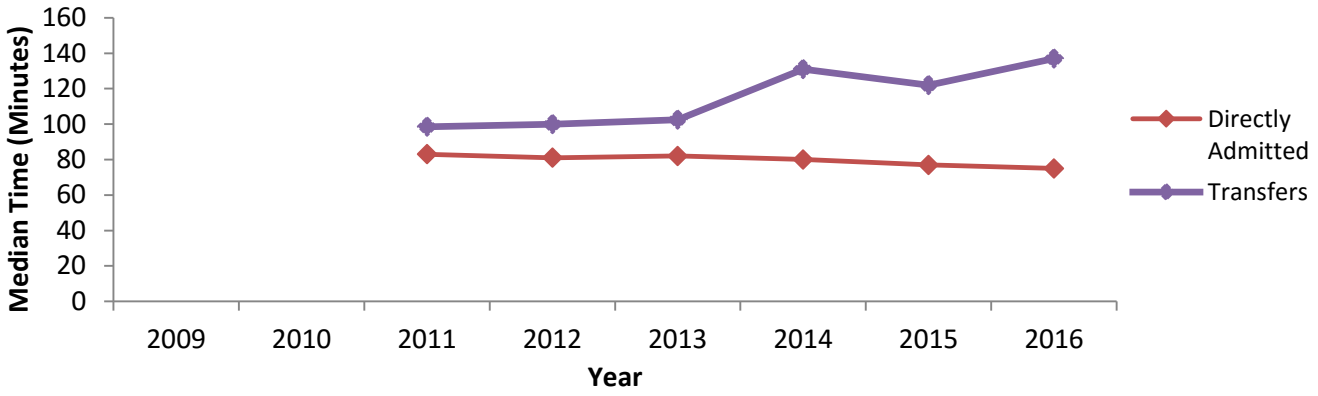


Table 23. Median time from first medical contact to balloon time by year among patients who arrived at the first or only hospital by ambulance, by patient type

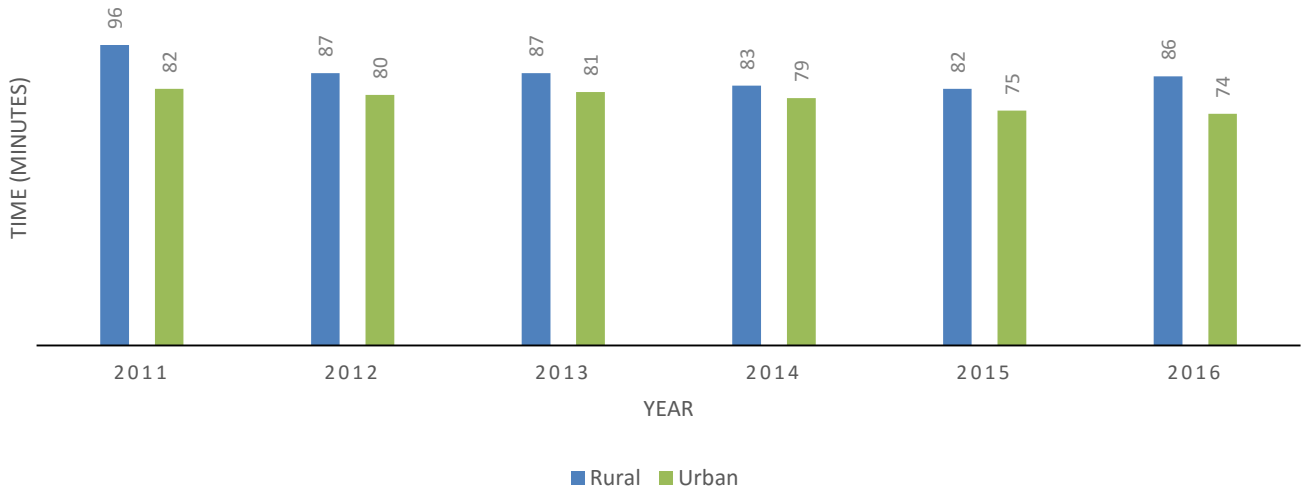
	Patient Type					
	Directly Admitted			Transfer		
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Median minutes	Reporting Hospitals (n)	Cases receiving primary PCI at STEMI receiving hospital (n)	Median minutes	Reporting Hospitals (n)
2009	--	--	--	--	--	--
2010	--	--	--	--	--	--
2011	313	**83**	26	76	**98.5**	11
2012	458	81	32	91	100	15
2013	597	82	36	74	102.5	14
2014	607	80	42	32	131	15
2015	636	77	44	36	122	13
2016	715	**75**	44	17	**137**	8

-- No data available

The median times from first medical contact to primary PCI were higher for transfer patients compared to directly admitted patients.

Fig 21 shows the median times from first medical contact to balloon times in directly admitted patients by community (urban/rural). The rural areas have higher median times from first medical contact to primary PCI compared to urban regions.

Fig 21: Median times from First Medical Contact to Balloon Times in Directly Admitted Patients by Community, 2011-2016



XXII. TOTAL ISCHEMIC TIME AMONG TRANSFER PATIENTS

According to some studies, "Ischemic Time is a better predictor than Door-to-Balloon Time for mortality and infarct size in ST-Elevation Myocardial Infarction".[8] These studies suggest that the focus of STEMI care should be directed to reducing the ischemic time rather than door-to-balloon time. This can be achieved by early initiation of therapy. **Figure 22** and **Table 24** below display the total ischemic time among STEMI transfer patients from 2011 to 2016, which was divided in to three categories: less than 120 minutes, 120–239 minutes, and 240 minutes or more. The best clinical outcomes are observed in patients who have total ischemic time <120 minutes. Total ischemic time less than 120 minutes was more common among patients who arrived at the STEMI referral hospital by ambulance (18.6%) than among patients who arrived by personal vehicle (11.1%). Half of the transfer patients arriving at the STEMI referral hospital by personal vehicle had a total ischemic time of 240 minutes or more while 32.1% of patients arriving by ambulance fell into this category.

Figure 22: Total ischemic time among transfer patients by mode of arrival to first hospital

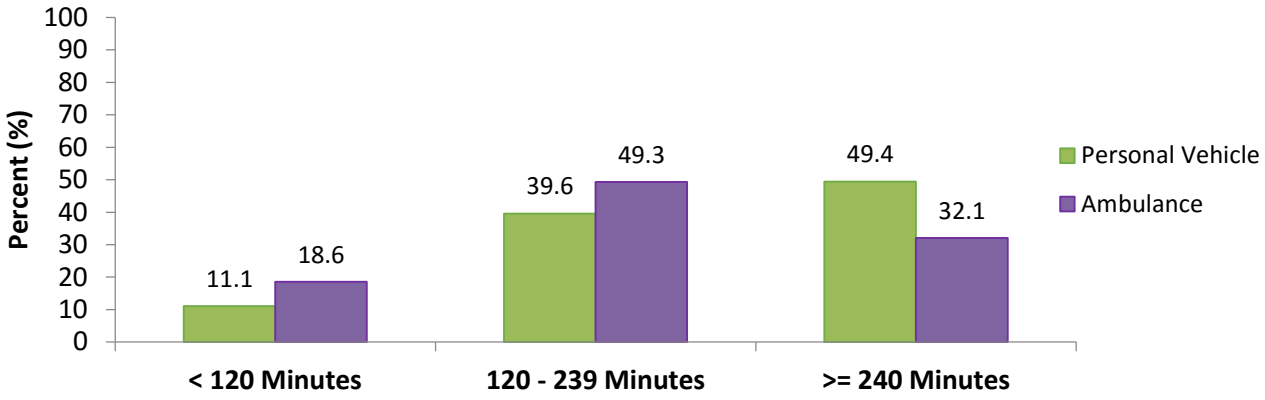


Table 24: Total ischemic time among transfer patients by mode of arrival to first hospital

Patient Type	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
	Total Ischemic Time < 120 Minutes, n (%)	Total Ischemic Time 120-239 Minutes, n (%)	Total Ischemic Time ≥ 240 Minutes, n (%)	Total Ischemic Time < 120 Minutes, n (%)	Total Ischemic Time 120-239 Minutes, n (%)	Total Ischemic Time ≥ 240 Minutes, n (%)	Reporting hospitals (n)
Transfer from other hospital	122 **(11.1)**	435 (39.6)	543 (49.4)	55 **(18.6)**	146 (49.3)	95 (32.1)	40

XXIII. TOTAL ISCHEMIC TIME AMONG DIRECTLY ADMITTED PATIENTS

Figure 23, Figure 24, Figure 25 and **Table 25** display the **total ischemic time** among STEMI patients from 2011 to 2016, which was divided in to three categories: less than 120 minutes, 120 – 239 minutes, and 240 minutes or more. The best clinical outcomes are observed in patients who have total ischemic time < 120 minutes.[8] **Figure 22** indicates that from 2011 to 2016, total ischemic time less than 120 minutes was more common among patients who arrived by ambulance than by personal vehicle. **Figure 24** indicates that from 2011 to 2016, total ischemic time of 240 minutes or more was more common among patients who arrived by personal vehicle than by ambulance. In 2016, 23.8% of the patients who arrived at the hospital by personal vehicle and 41.5% of the patients who arrived at the hospital by ambulance, had less than 120 minutes of total ischemic time. In 2016 and in the third category, 36.7% of the patients who arrived at the hospital by personal vehicle and 19.3% of the patients who arrived at the hospital by ambulance, had 240 minutes or more of total ischemic time.

Figure 23: Total ischemic time < 120 minutes among directly admitted STEMI patients by mode of arrival and year

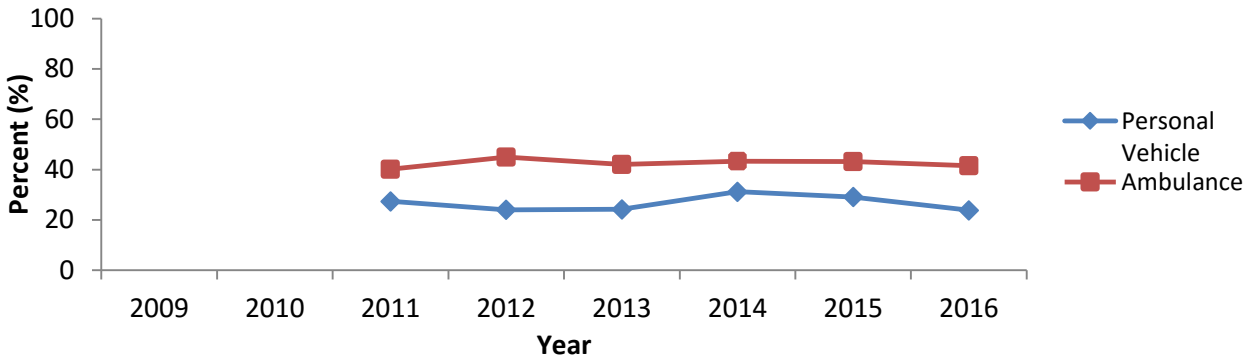


Figure 24: Total ischemic time 120 - 239 minutes among directly admitted STEMI patients by mode of arrival and year

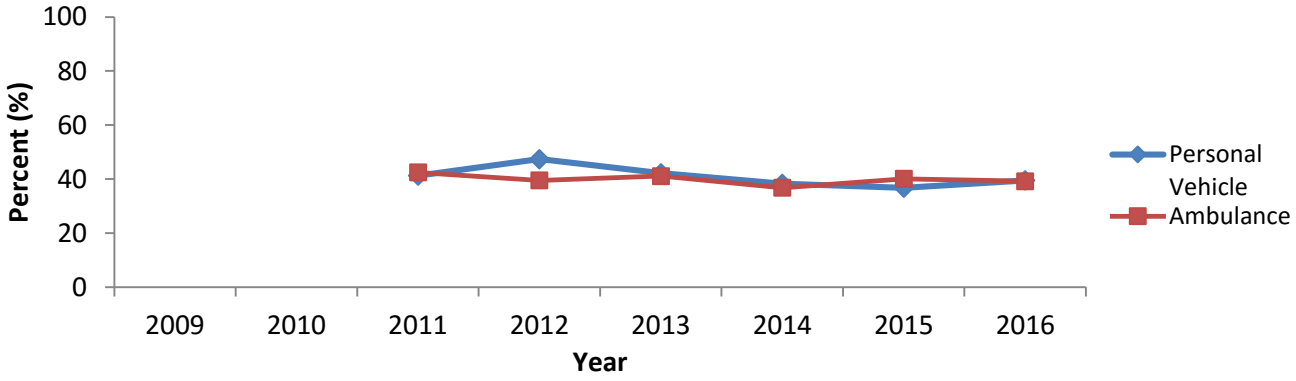


Figure 25: Total ischemic time ≥ 240 minutes among directly admitted STEMI patients by mode of arrival and year

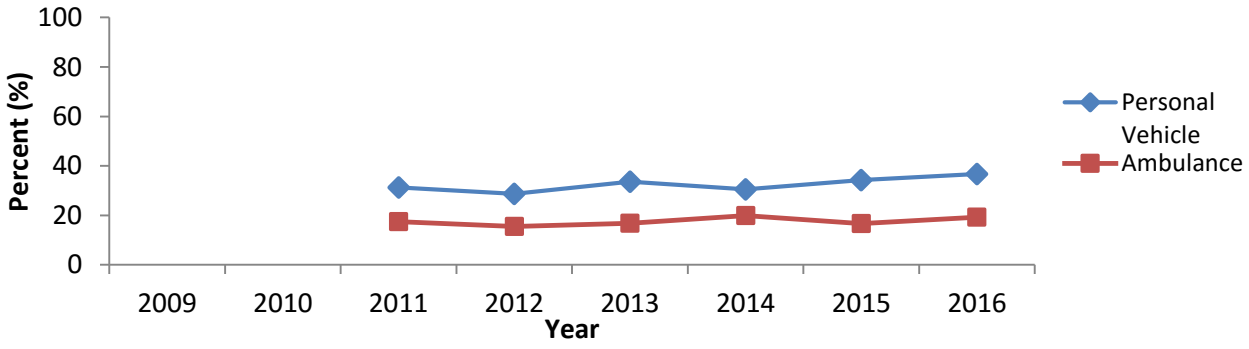


Table 25: Total Ischemic Time among directly admitted STEMI patients by mode of arrival and year

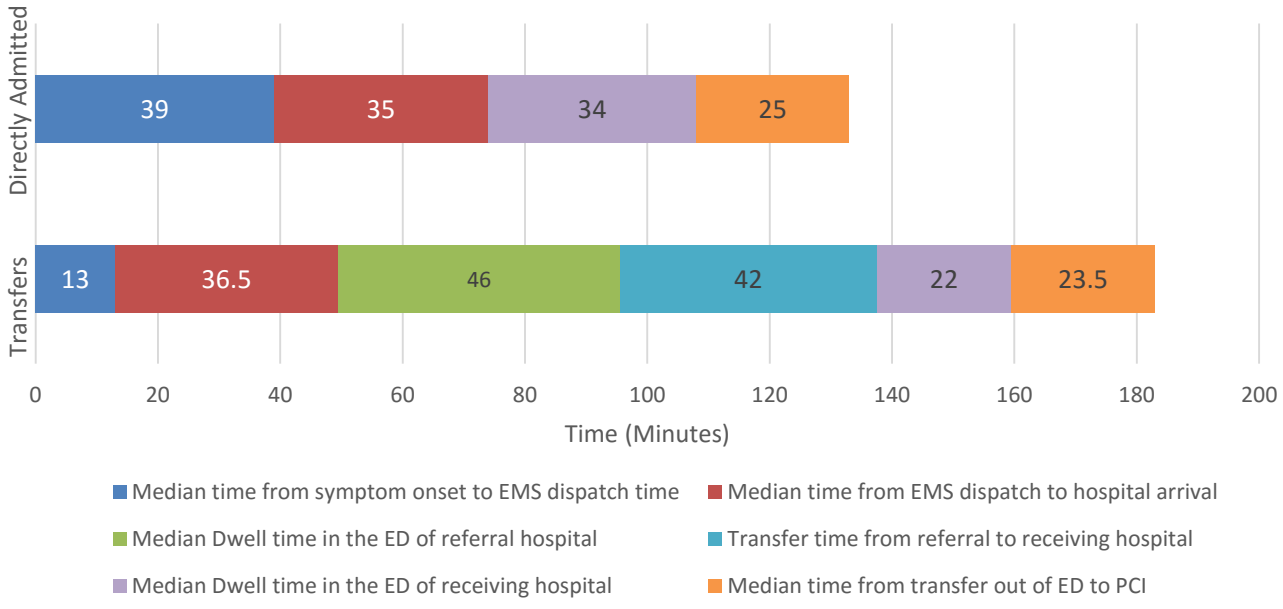
	Mode of arrival to first hospital						
	Personal vehicle			Ambulance			
Year	Total Ischemic Time < 120 Minutes, n (%)	Total Ischemic Time 120-239 Minutes, n (%)	Total Ischemic Time ≥ 240 Minutes, n (%)	Total Ischemic Time < 120 Minutes, n (%)	Total Ischemic Time 120-239 Minutes, n (%)	Total Ischemic Time ≥ 240 Minutes, n (%)	Reporting Hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	71 (27.4)	107 (41.3)	81 (31.3)	117 (40.1)	124 (42.5)	51 (17.5)	29
2012	91 (24.0)	180 (47.4)	109 (28.7)	189 (45.0)	166 (39.5)	65 (15.5)	34
2013	93 (24.2)	162 (42.2)	129 (33.6)	237 (42.0)	232 (41.1)	95 (16.8)	36
2014	144 (31.2)	177 (38.3)	141 (30.5)	228 (43.3)	194 (36.8)	105 (19.9)	43
2015	136 (29.1)	172 (36.8)	160 (34.2)	246 (43.2)	228 (40.1)	95 (16.7)	46
2016	125 (23.8)	208 (39.5)	193 (36.7)	271 (41.5)	256 (39.2)	126 (19.3)	48

-- No data available

XXIV. MEDIAN TIMES FROM SYMPTOM ONSET TO PRIMARY PCI IN DIRECTLY ADMITTED AND TRANSFER STEMI PATIENTS, 2016

The total median time from symptom onset to PCI in directly admitted patients is 133 minutes. The median time from symptom onset to EMS dispatch time is 39 minutes and the time from EMS dispatch to arrival at the receiving hospital is 35 minutes. **Fig 26** shows the median times for the year 2016 in directly admitted and transfer STEMI patients.

Fig 26: Median Times (in minutes) from Symptom Onset to Primary PCI in Directly Admitted and Transfer STEMI Patients, 2016



In 2016, the total median time from symptom onset to PCI in transfer patients is 183 minutes. It should be noted that the number of STEMI cases vary with each measure in the above chart. This is due to different missing values for each variable used in calculating the measures. There were less than 20 STEMI cases among transfer patients for the measures "Median time from symptom onset to EMS dispatch time", "Transfer Time" and the "Median time from EMS dispatch to arrival at referral hospital. There were adequate number of STEMI cases for all the other measures.

XXV. ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG TRANSFER PATIENTS

Figure 27 and **Table 26** show data on activation of the cardiac catheterization lab prior to hospital arrival, known as "pre cath lab activation", among 267 STEMI transfer patients in 2016 who arrived at the first hospital by personal vehicle or ambulance. The catheterization lab was activated prior to arrival at the receiving hospital for 43.1% of patients, not activated for 5.2% of patients and there were missing observations for 51.7% of the patients. Implementing an appropriate protocol for "pre cath lab activation" at the receiving hospital for transfer patients can reduce total ischemic time among these patients and improve outcomes.

Figure 27: Activation of catheterization lab among transfer patients whose mode of arrival to the first hospital was by personal vehicle or ambulance, Count and Percentage, 2015 and 2016

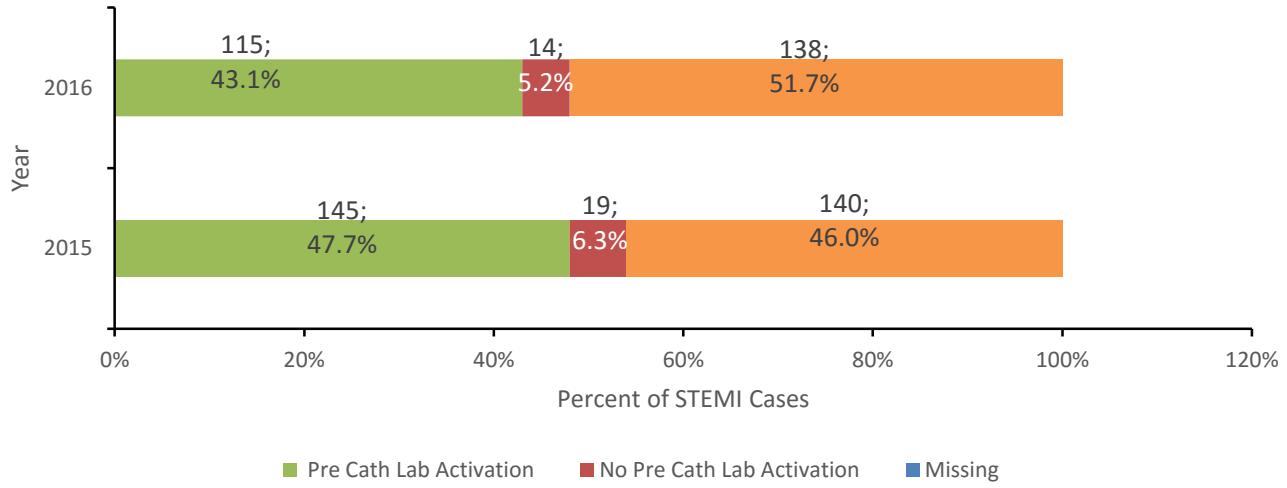


Table 26: Activation of catheterization lab among transfer patients whose mode of arrival to the first hospital was by personal vehicle or ambulance

Year	Pre Cath Lab Activation	No Pre Cath Lab Activation	Missing	Total STEMI Cases	Reporting Hospitals
	Number and Percent of Cases, n (%)	Number and Percent of Cases, n (%)	Number and Percent of Cases, n (%)		
2015	145 (47.7)	19 (6.3)	140 (46.0)	304	28
2016	115 (43.1)	14 (5.2)	138 (51.7)	267	33

XXVI. ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG DIRECTLY ADMITTED PATIENTS

Figure 28 and **Table 27** show data on activation of the cardiac catheterization lab prior to hospital arrival, known as "pre Cath lab activation", among 726 directly admitted STEMI patients in 2016 who arrived at the hospital by an ambulance. "Pre Cath lab activation" occurred for 54.3% but did not occur for 28.1% of the patients. Prehospital ECG within 10 minutes of first medical contact and accurate diagnoses of STEMI cases, when communicated to the receiving hospital lead to "pre Cath lab activation". Appropriate protocol should be implemented for "pre Cath lab activation" at the receiving hospital for STEMI patients arriving by ambulance. This can reduce the total ischemic time among these patients and improve the outcomes. Collaborative efforts between EMS providers, nursing staff, and physicians can increase the percentage of cases with "pre Cath lab activation" in Texas.

Figure 28: Activation of catheterization lab prior to hospital arrival among directly admitted patients whose mode of arrival was by ambulance, 2015 and 2016

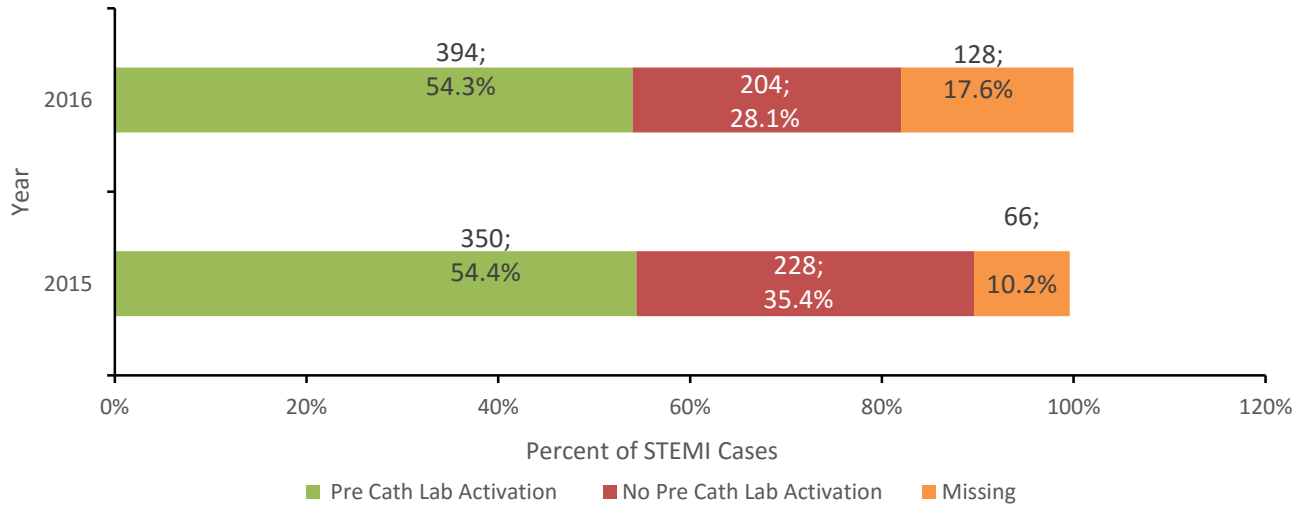


Table 27: Activation of catheterization lab prior to hospital arrival among directly admitted patients whose mode of arrival was by ambulance

Year	Pre Cath Lab Activation	No Pre Cath Lab Activation	Missing	Total STEMI Cases	Reporting Hospitals
	Number and Percent of Cases, n (%)	Number and Percent of Cases, n (%)	Number and Percent of Cases, n (%)		
2015	350 (54.4)	228 (35.4)	66 (10.2)	644	41
2016	394 (54.3)	204 (28.1)	128 (17.6)	726	44

XXVII. CARDIAC REHABILITATION REFERRAL

Figure 29 and **Table 28** display the cardiac rehabilitation referral among 15,223 STEMI patients at the time of discharge between 2008 and 2016. About 63.1% of the patients were referred to a cardiac rehabilitation program while 25.5% were not referred and 11.4% were ineligible for referral. The ineligible factors include medical reason, patient factors, and health care system factors. For example, if the patient has a medically unstable, life threatening condition, he is ineligible due to a medical reason. If the patient needs to be discharged to a nursing care facility for a long-term care, he is ineligible due to a patient factor. Health care system factors include no cardiac rehabilitation program within 60 minutes from the patient's home. A referral is defined as an official communication between the healthcare provider and the patient to recommend and carry out a referral order to an outpatient cardiac-rehabilitation program. According to CDC Cardiac Rehabilitation Facts, "Comprehensive cardiac rehabilitation has been shown to reduce re-hospitalization rates, reduce recurrent sudden cardiac death, lessen the need for cardiac medications, and increase the rate of persons returning to work".[9] Recent research suggests that physician referral is the most powerful predictor for cardiac rehabilitation enrollment.[9] Appropriate measures should be taken to improve the rates of cardiac rehabilitation referral.

Figure 29: Cardiac Rehabilitation Referral among STEMI Patients

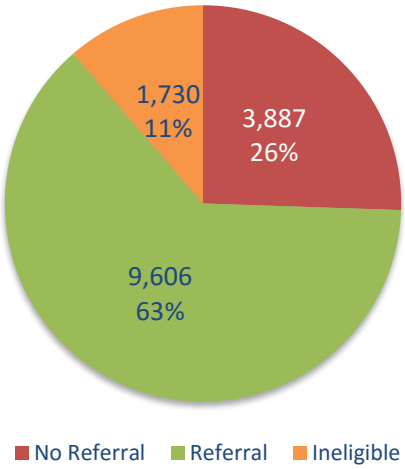


Table 28: Cardiac Rehabilitation Referral among STEMI Patients

	Cardiac Rehabilitation Referral			
	Yes	**No**	**Ineligible**	**Reporting Hospitals (n)**
Number	9,606	3,887	1,730	49
%	63.1	25.5	11.4	

XXVIII. COMORBIDITIES AMONG ACUTE MYOCARDIAL INFARCTION (AMI) PATIENTS

Figure 30 shows the percentage of comorbidities among all heart attack patients between the years 2008 and 2016. The chart indicates that among 48,458 heart attack patients, 77.7% were hypertensive, 61.0% had dyslipidemia (high cholesterol), 42% were obese, 39.8% had diabetes, 31.1% were current or recent smokers within the past year and 27.0% were found to be anemic. Hypertension is a very common and important risk factor for heart attack and efforts should be taken to mitigate the prevalence of hypertension.

Figure 30: Percentage of comorbidities among AMI patients

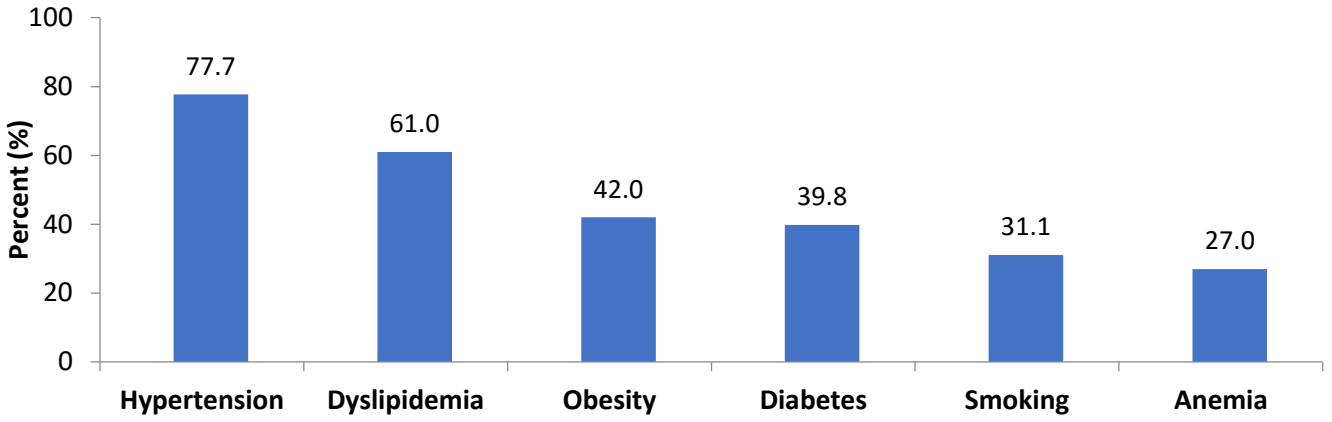
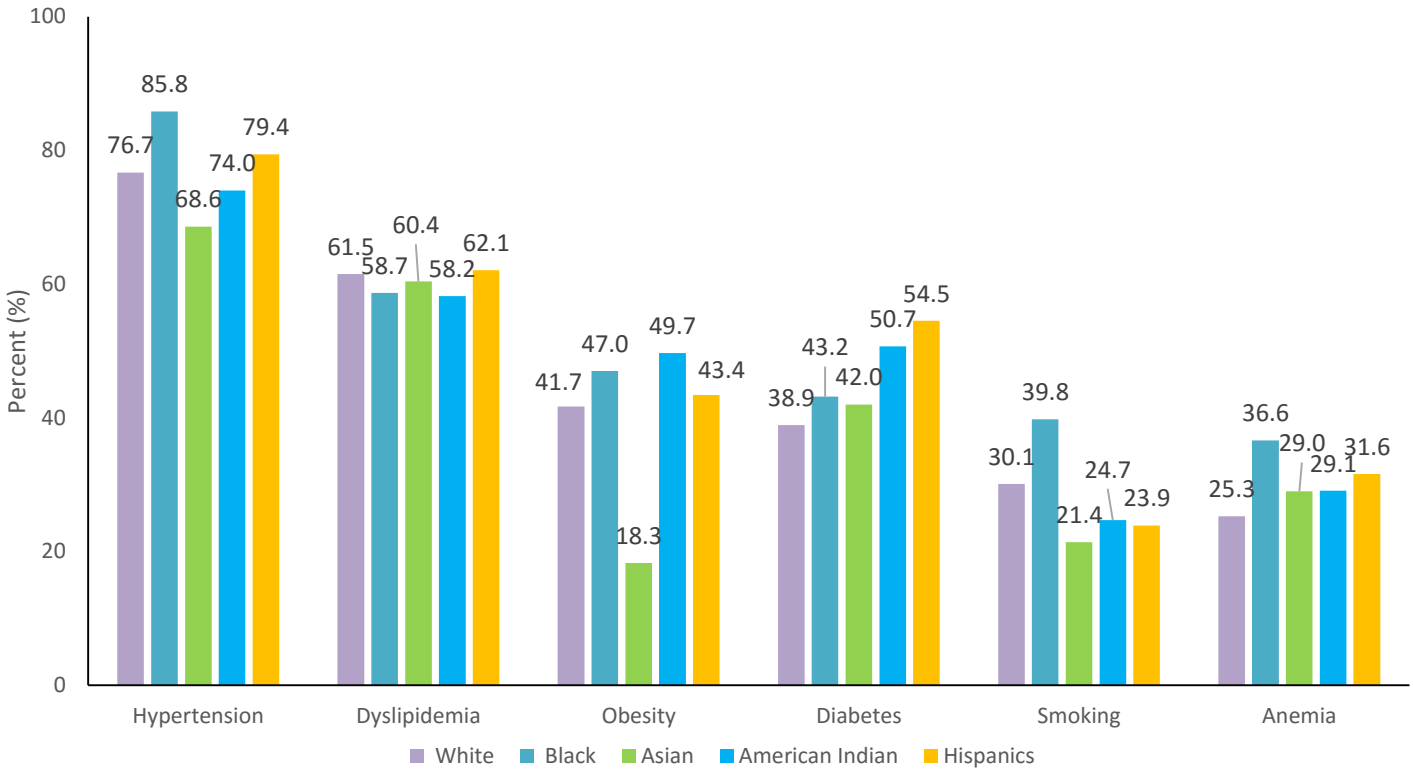


Table 29: Percentage of comorbidities among AMI patients

	Comorbidities						
	Hypertension	**Dyslipidemia**	**Obesity**	**Diabetes**	**Smoking**	**Anemia**	**Reporting Hospitals (n)**
Number	37,655	29,541	20,343	19,277	15,087	13,065	48
%	77.7	61.0	42.0	39.8	31.1	27.0	

We have further classified the comorbidities in heart attack patients between the years 2008 and 2016, by race and ethnicity. Among 39,905 whites, 76.7% were hypertensive, 61.5% had dyslipidemia, 41.7% were obese, 38.9% had diabetes, 30.1% were current or recent smokers within the past year and 25.3% were found to be anemic. In a total of 6,484 black AMI patients, 85.8% were hypertensive, 58.7% had dyslipidemia, 47% were obese, 43.2% had diabetes, 39.8% were current or recent smokers within the past year and 36.6% were found to be anemic. Among 11,011 Hispanics 79.4% were hypertensive, 62.1% had dyslipidemia, 54.5% had diabetes, 43.4% were obese, 23.9% were current or recent smokers within the past year and 31.6% were found to be anemic. Hypertension, obesity, smoking and anemia are more prevalent among African Americans compared to whites and Hispanics. Hispanics have relatively higher prevalence of diabetes when compared to other races.

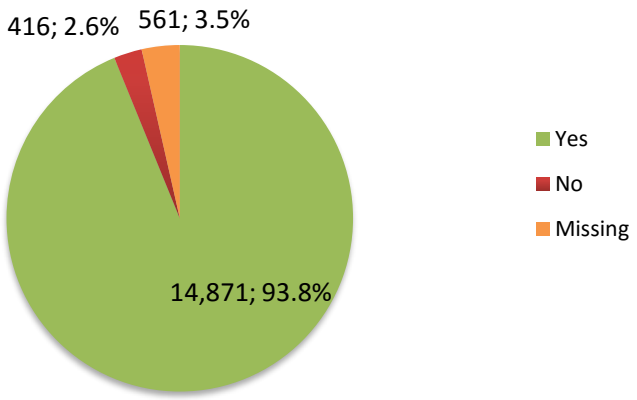
Fig 31: Percentage of comorbidities among race and ethnicity groups in AMI patients



XXIX. SMOKING CESSATION ADVICE UPON DISCHARGE

Smoking is a major modifiable risk factor for heart attack. Smoking increases the risk of atherosclerosis in the arteries, increases the levels of triglycerides, and decreases the levels of High–density lipoprotein (HDL) cholesterol, and thereby can raise the risk of heart attack.[11] Smoking causes one of every three deaths from cardiovascular disease.[11] According to the World Health Organization's Tobacco Free Initiative, patients who quit smoking after an episode of heart attack reduce their chances of having another heart attack by 50%.[12] Out of a total of 15,848 smokers among total heart attack cases, 14,871 (93.8%) were advised for smoking cessation at the time of discharge, 416 (2.6%) were not advised, and 561 (3.5%) were missing data on the measure.

Figure 32: Smoking cessation advice upon discharge among AMI patients who were current or recent smokers

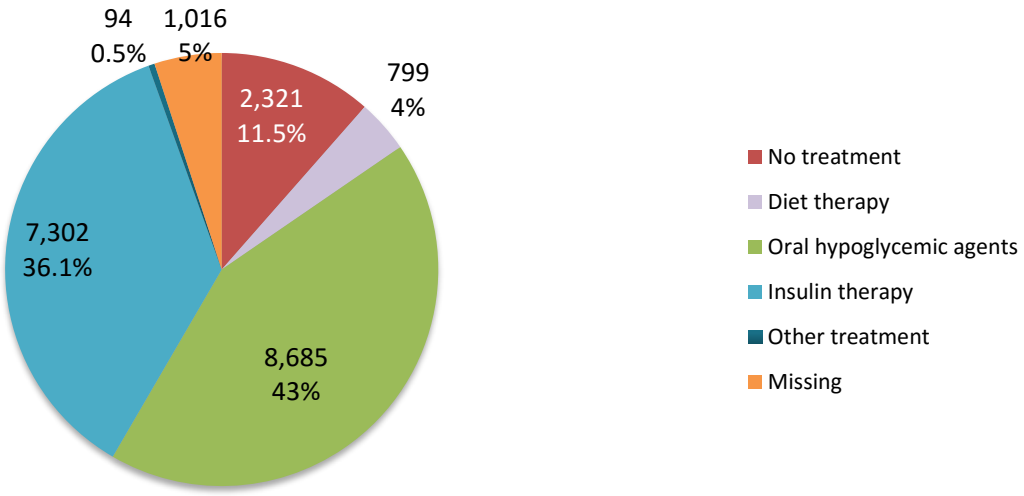


XXX. PRIOR DIABETES TREATMENT UPON ADMISSION

Between 2008 and 2016, and among 20,217 heart attack cases with a reported diabetes diagnosis, 11.5% were not on treatment for diabetes, 4% were only on diet treatment, 43% were on oral hypoglycemic agents, and 36.1% were on insulin therapy upon arrival at the hospital.

Among patients with diabetes who had health insurance, 10.2% reported that they were not on treatment for diabetes. Among patients with diabetes without health insurance, 19.3% reported that they were not on diabetes treatment. The results show that there is a gap in the treatment of diabetes in some patients which may have led to complications.

Figure 33: Prior Diabetes Treatment upon Admission among Acute Myocardial Infarction Patients

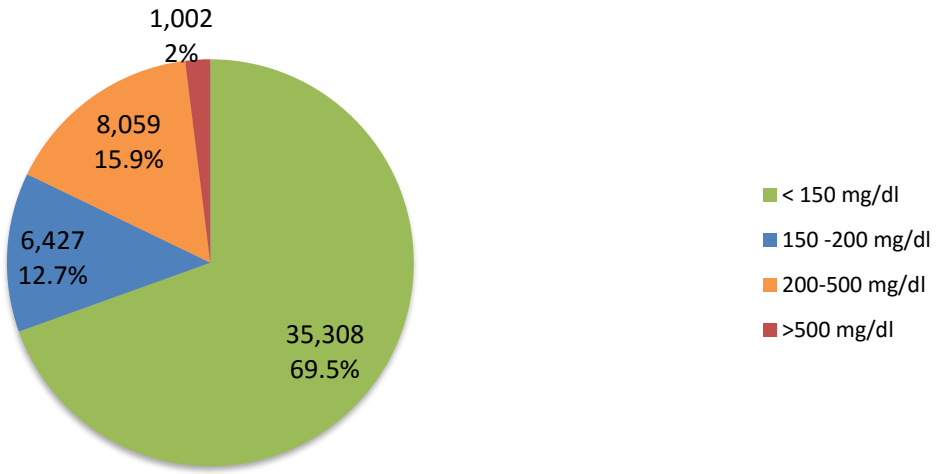


XXXI. EVALUATION OF TRIGLYCERIDE LEVELS AMONG ACUTE MYOCARDIAL INFARCTION PATIENTS

Hypertriglyceridemia may substantially increase cardiovascular disease risk among patients when compared to those with normal triglyceride levels.[13] It is recommended that patients with primary hypertriglyceridemia be evaluated for other cardiovascular risk factors such as central obesity, hypertension, liver dysfunction and other glucose metabolism abnormalities.[13] Normal triglyceride levels are below 150 mg/dl and levels between 150 and 199 mg/dl are considered as borderline high, levels between 200 and 499 mg/dl are high, and 500 mg/dl or more is considered very high.

Between 2008 and 2016, and among 50,796 heart attack cases, 69.5% had triglyceride levels below 150 mg/dL, 12.7% had levels between 150 and 200 mg/dL, and 15.9% patients had levels between 200 and 500 mg/dL, and 2.0% of patients had levels of 500 and above.

Figure 34: Evaluation of Triglyceride Levels among Acute Myocardial Infarction Patients



XXXII. ASPIRIN ADMINISTERED WITHIN FIRST 24 HOURS

Aspirin inhibits the enzyme, cyclooxygenase I in the platelets and thereby reduces platelet aggregation. Aspirin therapy given daily in the first 5 weeks after myocardial infarction has been well established to reduce early mortality.[15]

Among 50,796 AMI patients between 2008 and 2016, 95.6% were prescribed aspirin within first 24 hours, 2.2% were not given and 2.1% have contraindications to aspirin use. Among 16,286 STEMI patients, aspirin was prescribed within first 24 hours for 96.6% of patients, not prescribed for 2.0% of patients and contraindicated in 1.5% of patients. The administration of aspirin within first 24 hours among AMI patients did not differ by STEMI or non-STEMI cases.

Fig 35: Aspirin administered within first 24 hours, 2008 – 2016

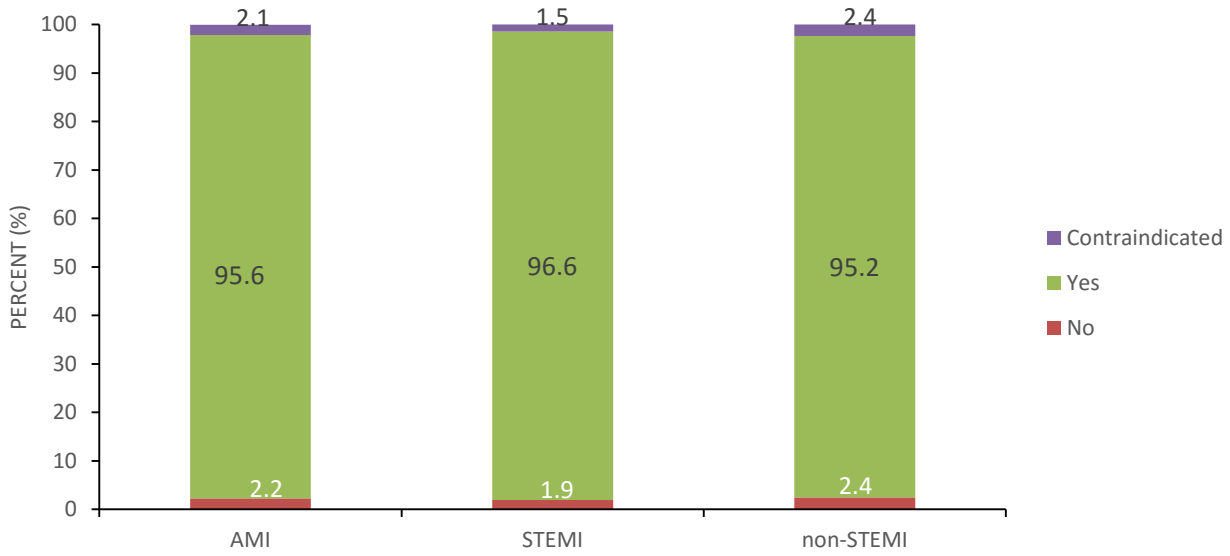


Table 30. Aspirin administered within first 24 hours, 2008 – 2016

	Total Cases	Yes, n (%)	No, n (%)	Contraindicated, n (%)
AMI	50,796	48,574 (95.6)	1,130 (2.2)	1,070 (2.1)
STEMI	16,286	15,724 (96.6)	318 (1.9)	238 (1.5)
Non-STEMI	34,510	32,850 (95.2)	812 (2.4)	832 (2.4)

XXXIII. ASPIRIN AT DISCHARGE

Among 50,796 AMI patients between 2008 and 2016, aspirin was prescribed at discharge for 84.5% of patients, 11.1% have missing values and aspirin was not prescribed at discharge for 2.1% of the patients. In a total of 16,286 STEMI patients, aspirin was prescribed at discharge for 85.6% of the patients and 11.5% have missing values. The administration of aspirin at discharge among AMI patients did not differ by STEMI or non-STEMI cases.

Fig 36. Aspirin prescribed at discharge, 2008 -2016

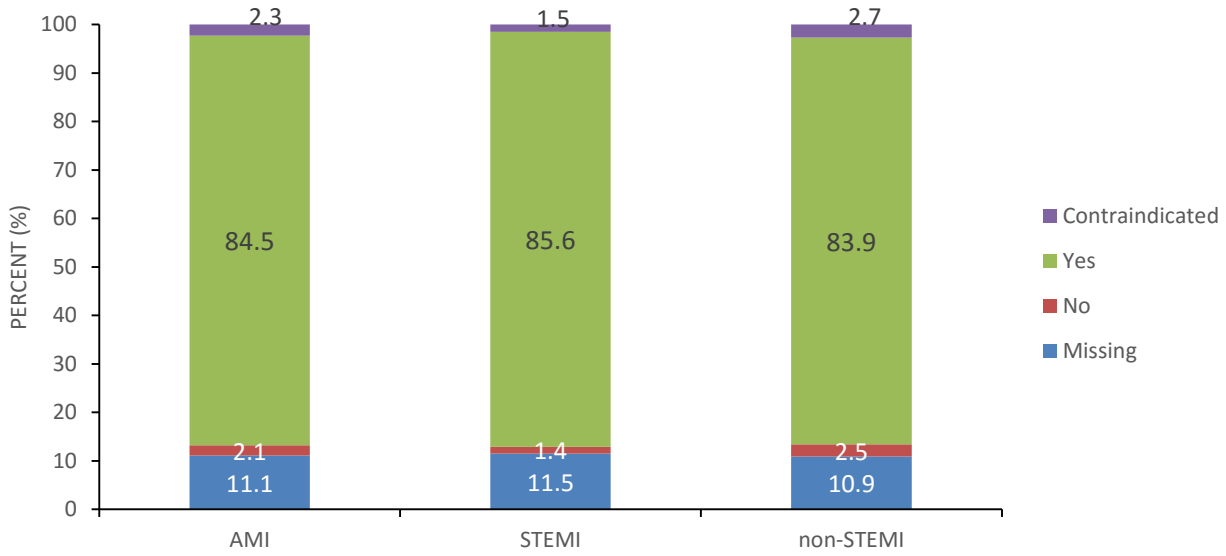


Table 31. Aspirin prescribed at discharge, 2008 -2016

	Total Cases	Yes, n (%)	No, n (%)	Missing, n (%)	Contraindicated, n (%)
AMI	50,796	42,900 (84.5)	1,081 (2.1)	5,634 (11.1)	1,178 (2.3)
STEMI	16,286	13,946 (85.6)	232 (1.4)	1,865 (11.5)	243 (1.5)
Non-STEMI	34,510	28,954 (83.9)	850 (2.5)	3,769 (10.9)	935(2.7)

XXXIV. BETA-BLOCKERS AT DISCHARGE

Beta-blockers may reduce mortality when used in of myocardial infarction patients. [15] They effectively reduce resting and exercise-induced heart rate, blood pressure, myocardial contractility and hence myocardial oxygen demand.[15] They are also associated with fewer dysrhythmias, limitation of infarct size and lower incidence of ventricular septal rupture, when used in AMI patients.[15]

Among 50,796 AMI patients between 2008 and 2016, Beta-blockers were prescribed for 81% of the patients, not prescribed for 2.6% of the patients, missing values in 11.1% and contraindicated in 5.4% of the patients. Among 16,286 STEMI patients, Beta-blockers were prescribed in 81.9% of the patients, not prescribed in 1.9% of the patients, missing values in 11.5% and contraindicated in 4.8% of the patients. The administration of Beta-blockers at discharge among AMI patients did not differ by STEMI or non-STEMI cases.

Fig 37. Beta-blockers prescribed at discharge, 2008 -2016

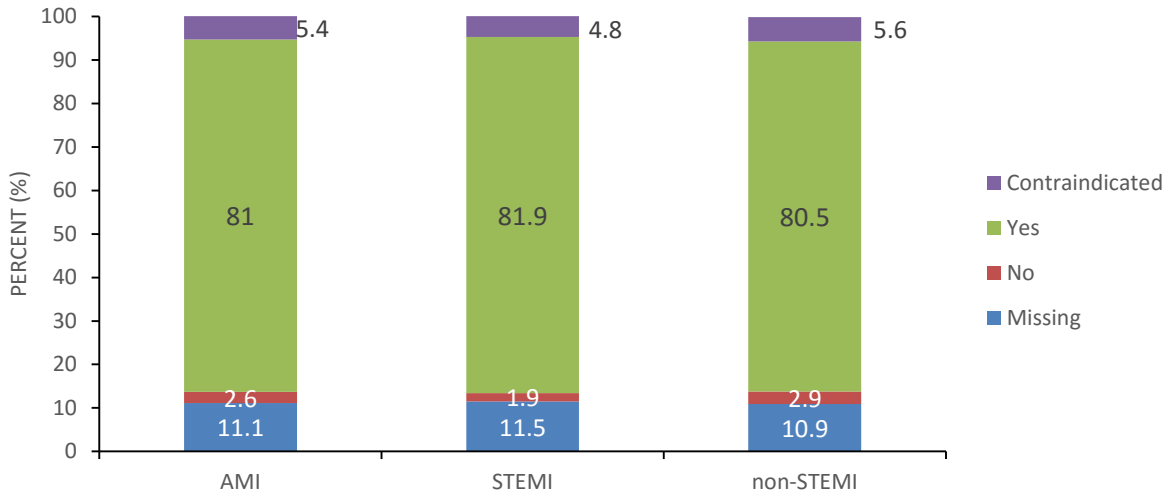


Table 32. Beta-blockers prescribed at discharge, 2008 -2016

	Total Cases	Yes, n (%)	No, n (%)	Missing, n (%)	Contraindicated, n (%)
AMI	50,796	41,130 (81.0)	1,303 (2.6)	5,633 (11.1)	2,725 (5.4)
STEMI	16,286	13,338 (81.9)	302 (1.9)	1,864 (11.5)	781 (4.8)
Non-STEMI	34,510	27,792 (80.5)	1,001 (2.9)	3,769 (10.9)	1,944 (5.6)

XXXV. STATIN AT DISCHARGE FOR LDL >= 100 MG/DL

Despite the strong evidence of mortality benefit conferred by statin therapy in post infarct patients, there is limited use of lipid lowering treatment among those who fulfil the criteria for myocardial infarction.[15] This may be due to the concerns about financial cost of the widespread use of the statins.[15] Vast majority of post infarct patients need a statin therapy as it shows modest benefits.

Between 2008 and 2016, and among 6,753 STEMI patients whose LDL was ≥ 100 mg/dl, statin was prescribed at discharge for 91.5% of the patients, not prescribed for 1.4% and contraindicated in 2% of the patients. In a total of 11,855 non-STEMI patients whose LDL was ≥ 100mg/dl, statin was prescribed at discharge for 86.1% of the patients, not prescribed for 3.1% and contraindicated in 3.4% of the patients. The prescription of statin drugs at discharge among AMI cases varied a little by STEMI or non-STEMI case. More STEMI cases were prescribed statins than non-STEMI cases.

Fig 38. Statin prescribed at discharge for LDL ≥ 100 mg/dl, 2008 -2016

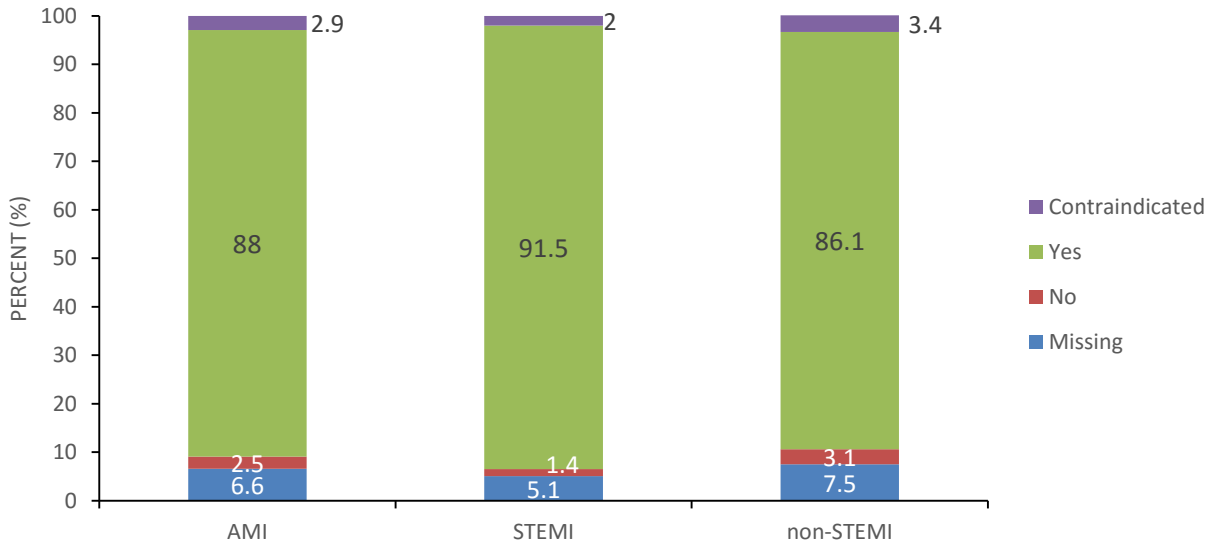


Table 33. Statin prescribed at discharge for LDL ≥ 100 mg/dl, 2008 -2016

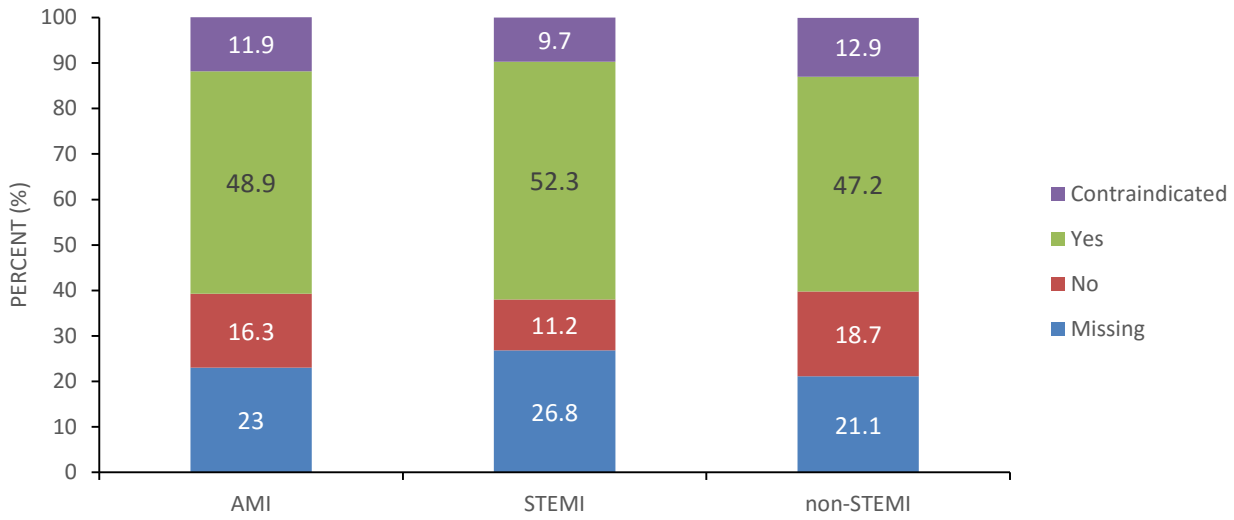
	Total Cases	Yes, n (%)	No, n (%)	Missing, n (%)	Contraindicated, n (%)
AMI	18,608	16,383 (88.0)	457 (2.5)	1,229 (6.6)	535 (2.9)
STEMI	6,753	6,179 (91.5)	93 (1.4)	344 (5.1)	136 (2.0)
Non-STEMI	11,855	10,204 (86.1)	364 (3.1)	885 (7.5)	399 (3.4)

XXXVI. ACE INHIBITORS OR ARB AT DISCHARGE (EJECTION FRACTION, EF < 40%)

Many studies have examined the role of Angiotensin converting enzyme (ACE) inhibitors or Angiotensin II receptor blockers (ARB) in the post infarct patients with reduced left ventricular function (decreased left ventricular ejection fraction, LVEF) and they found modest treatment benefits with these drugs.[15] ACE inhibitors competitively antagonize the conversion of enzyme, angiotensin I to angiotensin II and hence reduces systemic vascular resistance and cardiac afterload.[15] These drugs also reduce cardiac preload by decreasing aldosterone release and hence reduction of circulating fluid overload.[15] They have been shown to decrease the mortality rates in patients with MI or who recently had an MI with left ventricular (LV) systolic dysfunction, in patients with diabetes mellitus and with LV dysfunction, and also among patients with normal LV function.[4] ARBs are prescribed in those patients who have adverse effects with ACE inhibitors.

Between 2008 and 2016, and among 14,044 AMI patients with LVEF <40 %, ACE inhibitors were prescribed for 48.9% of the patients, not prescribed for 16.3% and contraindicated in 11.9% of the patients. Among 4,636 STEMI patients with LVEF < 40 %, ACE inhibitors were prescribed at discharge for 52.3% patients, not prescribed for 11.2% and contraindicated in 9.7% of the patients. The prescription of ACE inhibitors at discharge among AMI cases varied a little by STEMI or non-STEMI cases. More STEMI cases were prescribed ACE inhibitors than non-STEMI cases.

Fig 39. ACE Inhibitors prescribed at discharge for LVEF < 40%



ARB blockers at discharge were prescribed to 9.5% of 14,044 AMI patients and not prescribed for 57.3% of patients. Among 4,636 STEMI patients, ARBs at discharge were prescribed to 6.2% of patients and not prescribed to 58.4% of the patients. The prescription of ARBs at discharge among AMI cases varied a little by STEMI or non-STEMI case. More non-STEMI cases were prescribed ARBs than STEMI cases.

Fig 40. ARB prescribed at discharge for LVEF < 40%

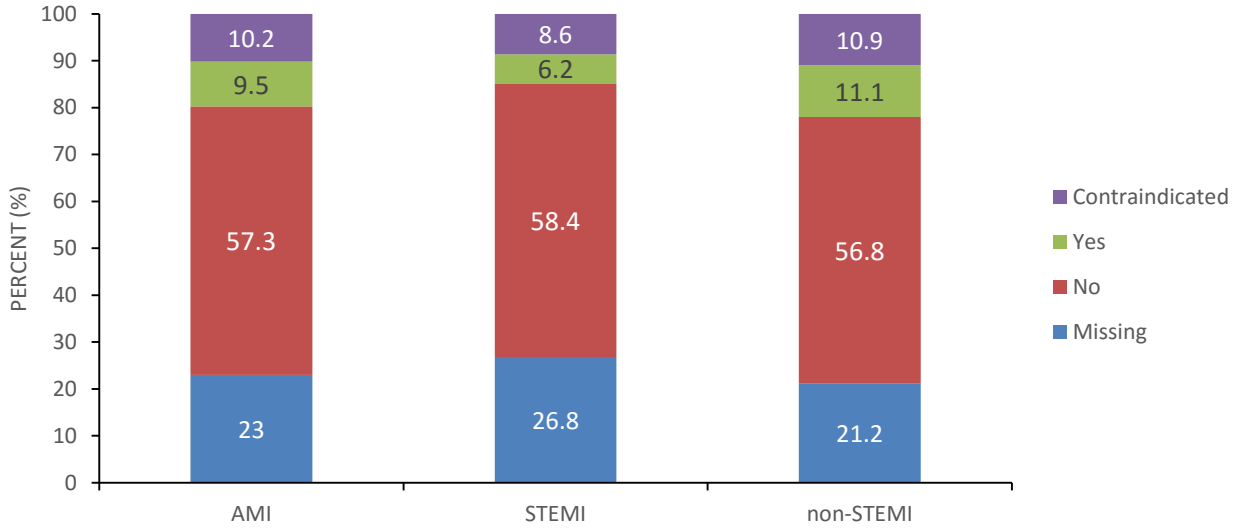


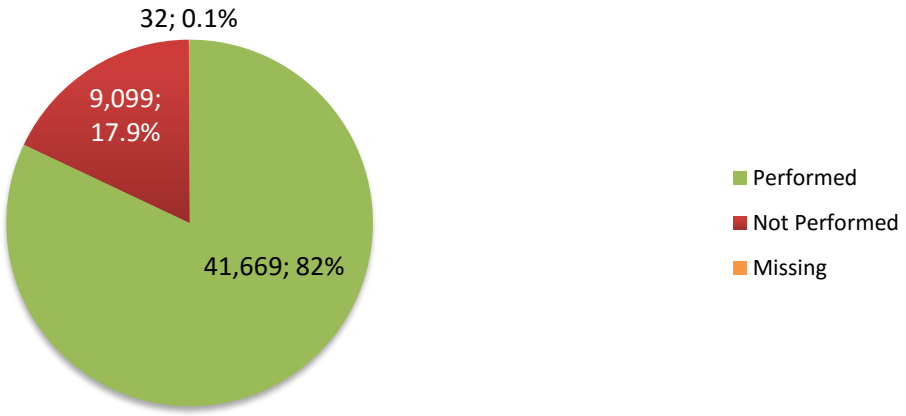
Table 34. ACE Inhibitors or ARB prescribed at discharge for LVEF < 40%

	Total Cases	Yes, n (%)		No, n (%)		Missing, n (%)		Contraindicated, n (%)	
		ACEI	ARB	ACEI	ARB	ACEI	ARB	ACEI	ARB
AMI	14,044	6,865 (48.9)	1,331 (9.5)	2,283 (16.3)	8,052 (57.3)	3,228 (23.0)	3,235 (23.0)	1,667 (11.9)	1,426 (10.2)
STEMI	4,636	2,424 (52.3)	285 (6.2)	521 (11.2)	2,706 (58.4)	1,241 (26.8)	1,244 (26.8)	450 (9.7)	401 (8.6)
Non-STEMI	9,408	4,441 (47.2)	1,046 (11.1)	1,762 (18.7)	5,346 (56.8)	1,987 (21.1)	1,991 (21.2)	1,217 (12.9)	1,025 (10.9)

XXXVII. LDL ASSESSMENT

Lipid panel was performed in 82.0% of 50,800 AMI patients between 2008 and 2016. Lipid panel and LDL assessment was not performed in 17.9% of patients. Among 16,289 STEMI patients, LDL assessment was done only in 82.0% of the patients as opposed to 100.0%.

Fig 41: LDL Assessment in Acute Myocardial Infarction Patients



XXXVIII. UNADJUSTED IN-HOSPITAL MORTALITY RATES

Fig 42 below shows the unadjusted in-hospital mortality rates between 2008 and 2016. The mortality rates range from as low as 5.2% in 2008 to as high as 7% in 2013 among STEMI patients. Among non-STEMI patients, the mortality rates range from as low as 0% in 2008 to as high as 3.9% in 2010. In 2016, the unadjusted in-hospital mortality rates for STEMI patients were twice as high as non-STEMI patients.

Fig 42. Unadjusted In-Hospital Mortality Rates among STEMI, non-STEMI and AMI (both) cases, 2008 - 2016

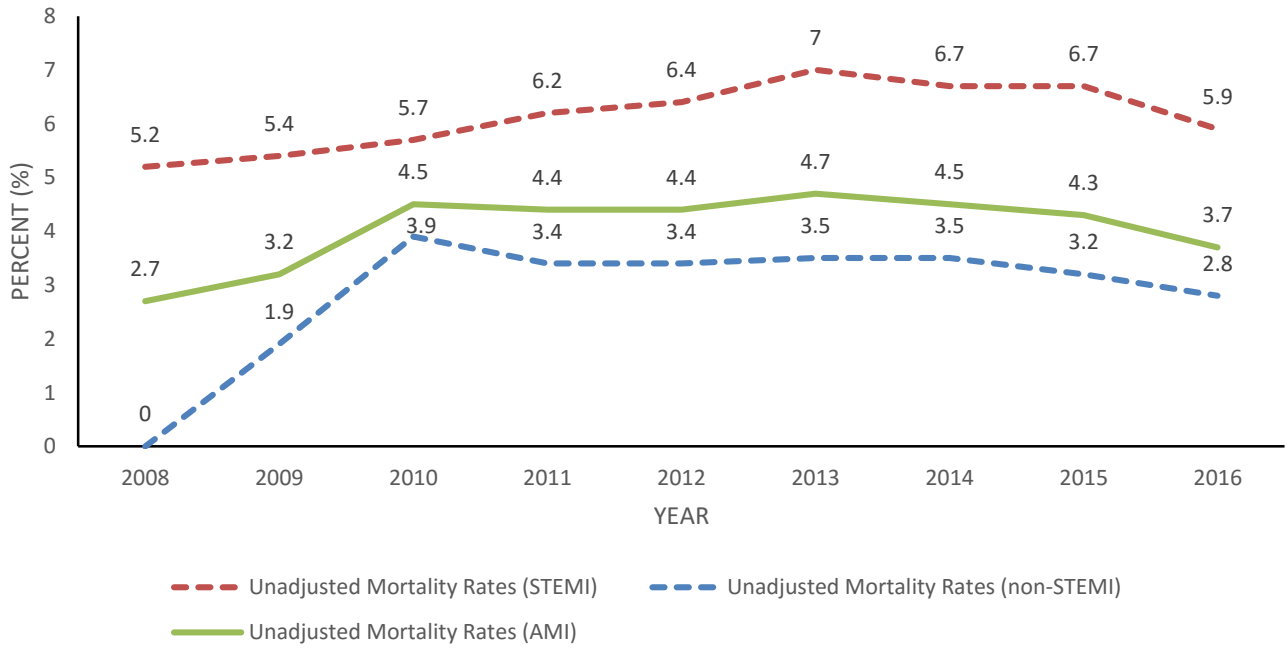


Table 35. Unadjusted In-Hospital Mortality Rates among STEMI and non-STEMI cases, 2008 - 2016

YEAR	Total STEMI cases	In-hospital Deaths, n (%)	Total non-STEMI cases	In-hospital Deaths, n (%)	Total AMI cases	In-hospital Deaths, n (%)
2008	58	3 (5.2)	54	0 (0)	112	3 (2.7)
2009	296	16 (5.4)	517	10 (1.9)	813	26 (3.2)
2010	1,164	66 (5.7)	2,182	84 (3.9)	3,346	150 (4.5)
2011	1,908	119 (6.2)	3,599	121 (3.4)	5,507	240 (4.4)
2012	2,197	141 (6.4)	4,679	159 (3.4)	6,876	300 (4.4)
2013	2,413	169 (7.0)	4,998	176 (3.5)	7,411	345 (4.7)
2014	2,571	171 (6.7)	5,726	201 (3.5)	8,297	372 (4.5)
2015	2,752	183 (6.7)	6,115	195 (3.2)	8,867	378 (4.3)
2016	2,930	174 (5.9)	6,641	184 (2.8)	9,571	358 (3.7)

APPENDIX I – DATA SOURCES AND DEFINITIONS

Glossary

First hospital refers to a facility where a patient is seen initially.

STEMI referral hospital refers to a facility where a patient is seen initially and from which the patient is transferred to a STEMI receiving facility. All STEMI referral hospitals are considered **first hospitals**.

STEMI receiving hospital refers to a facility to which a patient is transferred after being initially seen at a non-PCI-capable hospital or STEMI referral hospital.

Table 1 (pg.8)

Data Source: Texas Behavioral Risk Factor Surveillance System Public Use Data File, 2011-15. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Table 2 (pg.8)

Data Sources: Texas Hospital Inpatient Discharge Public Use Data File, 2008-14. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas; and County-Level Population Data, 2008-14. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Hospitalization rates were based on hospital records for which acute myocardial infarction was coded as the principal diagnosis, using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 410.00-410.01, 410.10-410.11, 410.20-410.21, 410.30-410.31, 410.40-410.41, 410-.50-410.51, 410.60-410.61, 410.70-410.71, 410.80-410.81, 410.90-410.91, a classification defined in the Specifications Manual for National Hospital Inpatient Quality Measures; exclude records for HIV and drug/alcohol use patients and non-residents hospitalized in-state; and were generated using the 2000 Projected U.S. Standard Population for age-adjustment and the following age-adjustment groups: 0-4, 5-9, 10-14, 15-34, 35-64, 65+.

Figure 1 (pg.9)

Data Sources: County-Level Mortality Data, 2009-15. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas; and County-Level Population Data, 2009-15. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Mortality rates were based on death records for which heart attack was coded as the underlying cause of death, using International Classification of Diseases, Tenth Revision (ICD-10) codes I21-I22; and generated using the 2000 U.S. Standard Population for age-adjustment and the following age-adjustment groups: 0, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74,75+

Figure 2 (pg. 10)

Source: Bates, E.R. and Jacobs, A.K. (2013). Time to treatment in patients with STEMI. *The New England Journal of Medicine, 369* (10), 889-892.

PRE-HOSPITAL ECG WITHIN 10 MINUTES OF FIRST MEDICAL CONTACT (pgs. 15-16)

Definition
Time to pre-hospital ECG was estimated by measuring the time elapsed from first medical contact (when the patient was first evaluated by either emergency medical services or another healthcare provider prior to arrival at the hospital) to receipt of first ECG among patients arriving at the hospital by ambulance and receiving their first ECG prior to arrival at the hospital.

Population excludes patients:

- <18 years old
- Arriving at STEMI receiving hospital via personal vehicle, mobile ICU, or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving first ECG after arrival at STEMI receiving hospital
- Receiving first ECG>24 hours after first medical contact
- With incomplete records—i.e., records with missing data for any variable used to define the population

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG TRANSFER PATIENTS (pg. 17)

Definition
Time to ECG was estimated by measuring the time elapsed from arrival at a STEMI referral hospital to receipt of first ECG. Thus, for episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock time to ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI referral hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG DIRECTLY ADMITTED PATIENTS (pg.18)

Definition
Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of first ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI receiving hospital via mobile ICU or air

- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI receiving hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG TRANSFER PATIENTS (pg.19)

Definition
Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of first ECG. Thus, for episodes of care involving patients received as transfers at a STEMI receiving hospital, the date and time of arrival at the transferring hospital, as documented by the STEMI receiving hospital, was used to clock time to ECG.

Population excludes patients:
- <18 years old
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI referral hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG DIRECTLY ADMITTED PATIENTS (pgs.20 -21)

Definition
Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of first ECG.

Population excludes patients:
- <18 years old
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI receiving hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF REFERRAL HOSPITAL (pgs. 21-22)

Definition
Dwell time in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to discharge at the STEMI referral hospital.

Population excludes patients:
- <18 years old

- Diagnosed with non-STEMI heart attack
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI referral hospital
- Not discharged and transferred to another hospital for PCI
- Transferred >24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG TRANSFER PATIENTS (pgs. 22 - 23)

Definition
Time spent in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to transfer out of the emergency department of the STEMI receiving hospital. Thus, for episodes of care involving patients received as transfers at the STEMI receiving hospital, the time elapsed reflects wait time at the subsequent hospital and not at the STEMI referral hospital.

Population excludes patients:
- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI receiving hospital
- Spending >24 hours in the emergency department of STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG DIRECTLY ADMITTED PATIENTS (pg.23)

Definition
Time spent in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to transfer out of the emergency department of the STEMI receiving hospital.

Population excludes patients:
- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI receiving hospital
- Spending >24 hours in the emergency department of STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR TO NEEDLE TIME (pgs. 23-24)

Definition

Door to needle time was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of fibrinolytic therapy at the STEMI referral hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock door to needle time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving percutaneous coronary intervention for reperfusion therapy
- With a non-system reason for delay of fibrinolysis
- Receiving fibrinolysis >6 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR TO NEEDLE TIME WITHIN 30 MINUTES AMONG TRANSFER PATIENTS (pgs. 25-26)

Definition
Door to needle time was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of fibrinolytic therapy at the STEMI referral hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock door to needle time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving percutaneous coronary intervention for reperfusion therapy
- With a non-system reason for delay of fibrinolysis
- Receiving fibrinolysis >6 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR TO BALLOON TIME FOR DIRECTLY ADMITTED PATIENTS (pgs. 26-27)

Definition
Door to balloon time was estimated by measuring the time elapsed from arrival at the hospital to receipt of primary percutaneous coronary intervention.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air

- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR TO BALLOON TIME WITHIN 90 MINUTES FOR DIRECTLY ADMITTED PATIENTS (pgs. 27 - 28)

Definition
Door to balloon time was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of primary percutaneous coronary intervention.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR TO BALLOON TIME FOR TRANSFER PATIENTS (pgs. 28 -29)

Definition
Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock first door to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR TO BALLOON TIME WITHIN 120 MINUTES FOR TRANSFER PATIENTS (pgs.29 -30)

Definition
Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock first door to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

FIRST DOOR TO BALLOON TIME WITHIN 90 MINUTES FOR TRANSFER PATIENTS (pgs.31 -32)

Definition
Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

FIRST MEDICAL CONTACT TO BALLOON TIME (pgs. 32-33)

Definition
Time from the first medical contact by EMS to the primary percutaneous coronary intervention in both transfer and directly admitted patients is referred as first medical contact to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

TOTAL ISCHEMIC TIME AMONG STEMI TRANSFER PATIENTS (pgs. 33-34)

Definition
Ischemic Time was estimated by measuring the time from symptom onset to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

TOTAL ISCHEMIC TIME AMONG STEMI DIRECTLY ADMITTED PATIENTS (pgs. 34-36)

Definition
Ischemic Time was estimated by measuring the time from symptom onset to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

MEDIAN TIMES FROM SYMPTOM ONSET TO PRIMARY PCI IN DIRECTLY ADMITTED AND TRANSFER STEMI PATIENTS (pgs. 36 -37)

Definition
The median times from the symptom onset to the primary percutaneous coronary intervention in both transfer and directly admitted patients are calculated.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG TRANSFER PATIENTS (pgs.37 -38)

Definition
Prehospital activation of the cardiac catheterization lab prior to arrival of transfer patients.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Directly admitted to STEMI receiving hospital
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG DIRECTLY ADMITTED PATIENTS (pgs.38-39)

Definition
Prehospital activation of the cardiac catheterization lab prior to arrival of directly admitted patients. Prehospital EKG identifies STEMI patients and assists in cardiac lab activation prior to arrival of the patients at the hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Directly admitted to STEMI receiving hospital
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention

CARDIAC REHABILITATION REFERRAL (pgs. 39-40)

Definition

A referral is defined as an official communication between the healthcare provider and the patient to recommend and carry out a referral order to an outpatient cardiac rehabilitation program. Many people with heart disease can benefit from cardiac rehabilitation. The purpose of cardiac rehabilitation is to reduce morbidity and mortality associated with cardiovascular illness by modifying the patient's coronary risk factors.

Population excludes patients:

- <18 years old
- With incomplete records—i.e., records with missing data for any variable used to define the population
- Deceased at discharge
- Diagnosed with non-STEMI heart attack

COMORBIDITIES AMONG AMI PATIENTS (pgs. 40-42)

Definition

The simultaneous presence of two chronic diseases or conditions in a patient. For example, the simultaneous presence of hypertension or diabetes or obesity or dyslipidemia or smoking history in a heart attack patient. According to the World Health Organization (WHO) definition, anemia is defined as a hemoglobin value < 12g/dl in women and < 13g/dl in men.

Population excludes patients:

- <18 years old
- With incomplete records – i.e., records with missing data for comorbidities.

SMOKING CESSATION ADVICE UPON DISCHARGE (pgs.42-43)

Definition

Smoking cessation advice or counseling given during discharge among patients who smoked cigarettes any time in the year prior to hospital arrival.

Population excludes patients:

- <18 years old
- Not reporting cigarette smoking at any time in the year prior to hospital arrival
- Deceased at discharge

PRIOR DIABETES TREATMENT UPON ADMISSION (pg.43)

Definition

Prior anti-diabetic treatment for admitted diabetes patients of Acute Myocardial Infarction. The treatment includes diet therapy, insulin therapy or any other oral hypoglycemic drugs.

Population excludes patients:

- <18 years old

EVALUATION OF TRIGLYCERIDE LEVELS AMONG ACUTE MYOCARDIAL INFARCTION PATIENTS (pg.44)

Definition
High triglyceride levels above 150 mg/dl has been linked to an increased risk of heart disease.

Population excludes patients:
- <18 years old

ASPIRIN ADMINISTERED WITHIN FIRST 24 HOURS (pgs. 44-45)

Definition: Medication administered within first 24 hours.

Population excludes patients:
- <18 years old

ASPIRIN AT DISCHARGE (pgs. 45-46)

Population excludes patients:
- <18 years old

BETA-BLOCKERS AT DISCHARGE (pgs. 46-47)

Population excludes patients:
- <18 years old

STATIN AT DISCHARGE FOR LDL >= 100 MG/DL (pgs. 47-48)

Population excludes patients:
- <18 years old
- With LDL < 100 mg/dl

ACE INHIBITORS OR ARB AT DISCHARGE (EF < 40%) (pgs. 48-50)

Population excludes patients:

- <18 years old
  With LVEF ≥ 40%

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